(Systems) Saw Tooth.

نسألكم الدعاء

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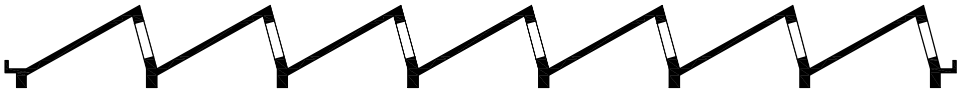
اذا حملت تطبيق RC Structures YASSER EL LEATHY على تليفونك المحمول او اللوح السطحى ستستطيع أن تشغل أفلام شرح للمقاطع التى تحتوى على رمز

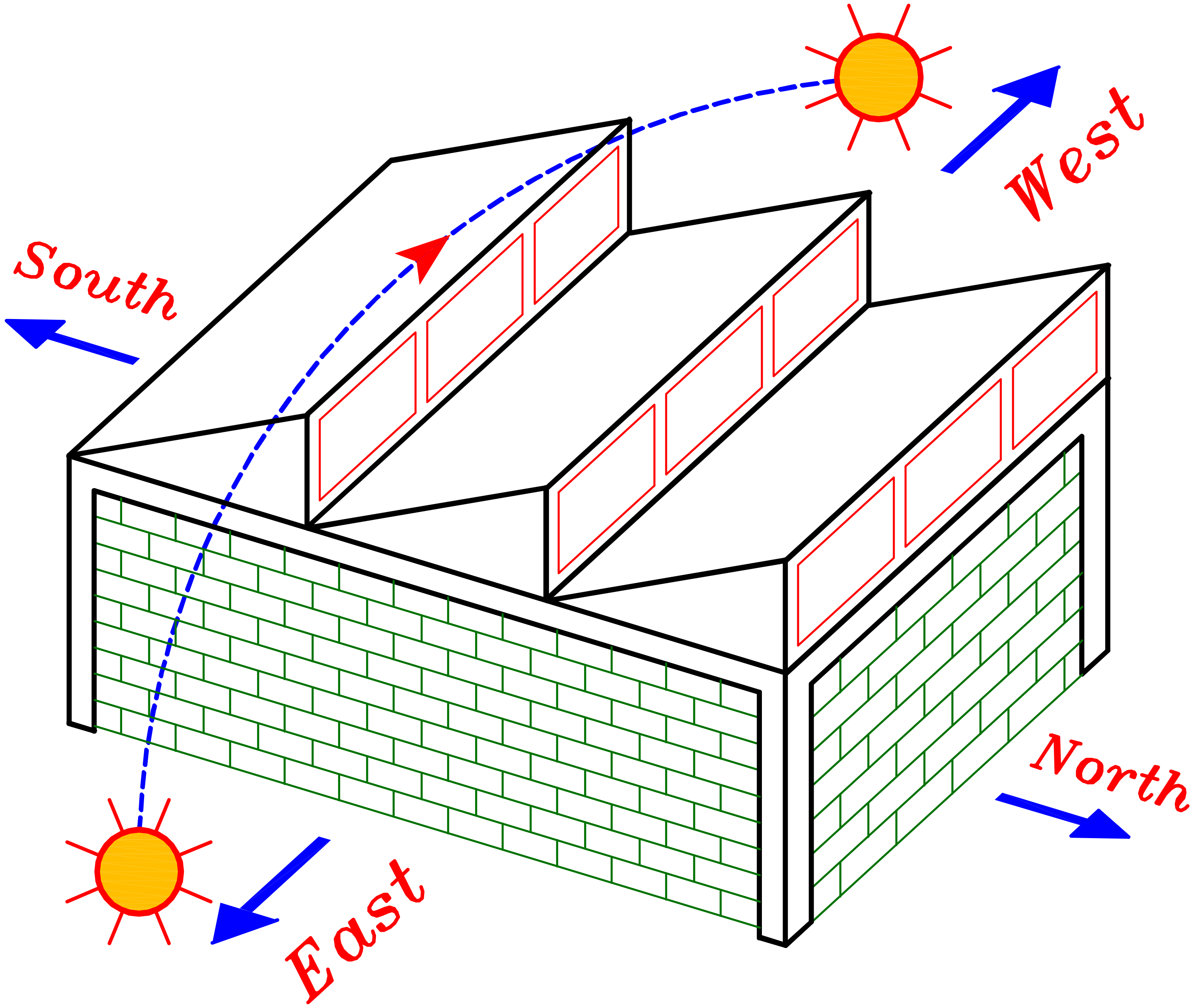
Saw Tooth. Table of Contents.

Saw Tooth Structures



Introduction.

Saw Tooth عباره عن بلاطات مائله (تشبه أسنان المنشار) محمولة على System إنشائى يعتمد نوع هذا ال System على المسافه بين الأعمده .

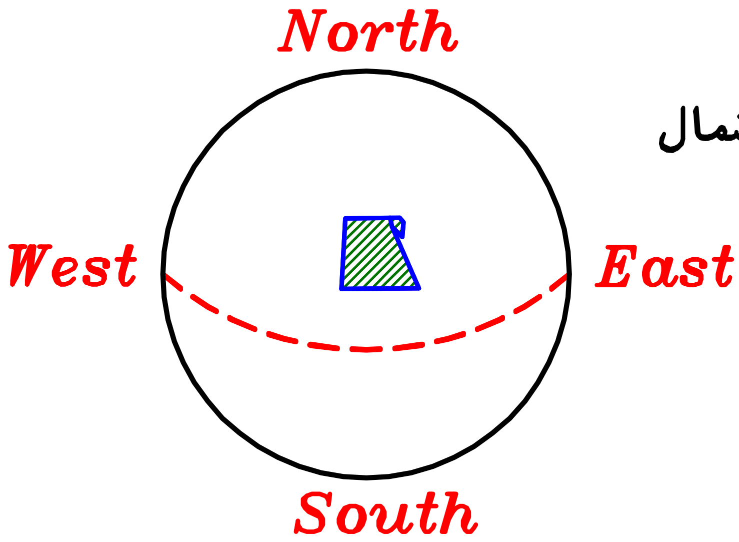


حفظ | دائماً سهم الشمال خارج من الشباك

و يستخدم هذا النوع من البلاطات عند طلب إضاءه غير مباشره داخل المبنى .
لذلك نضع النوافذ فى إتجاه الشمال فقط وذلك ل :

١- لعمل إضاءه غير مباشره

لوجود مصر عند مدار السرطان أى شمال شمال خط الاستواء فتشرق الشمس على مصر من اتجاه الجنوب الشرقى و تغرب من اتجاه الجنوب الغربى



أى أنه لعمل اضاءه غير مباشره فى مصر لا نضع أى نوافذ فى اتجاه الجنوب .

٢- لكى تكون النوافذ فى إتجاه البحرى (للتهويه الجيده) .

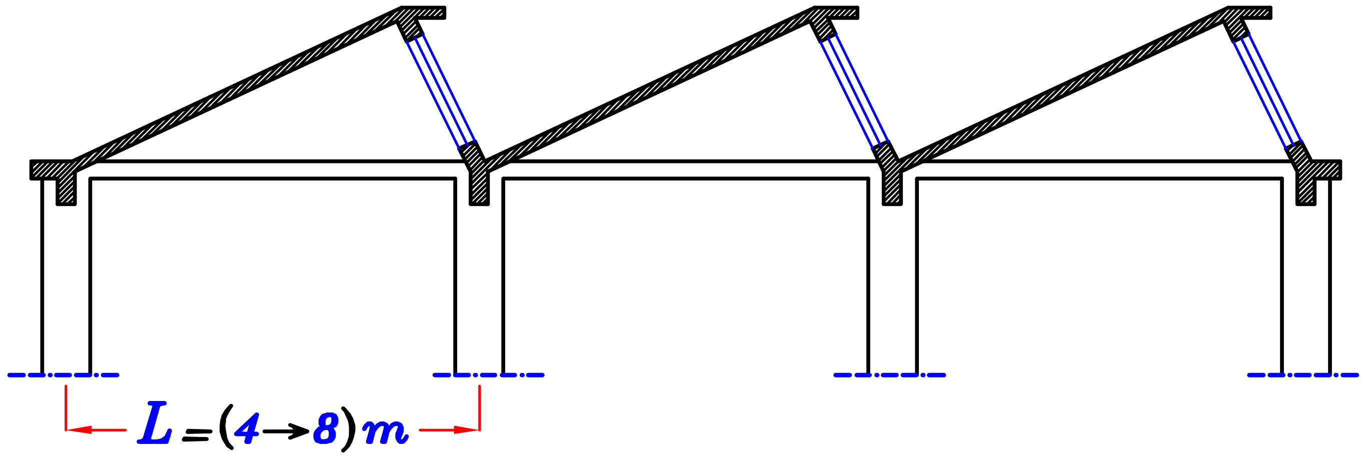
و لذلك فإنه ممنوع وضع أى نوافذ فى هذا الـ *System* إلا فى إتجاه الشمال فقط .

حفظ

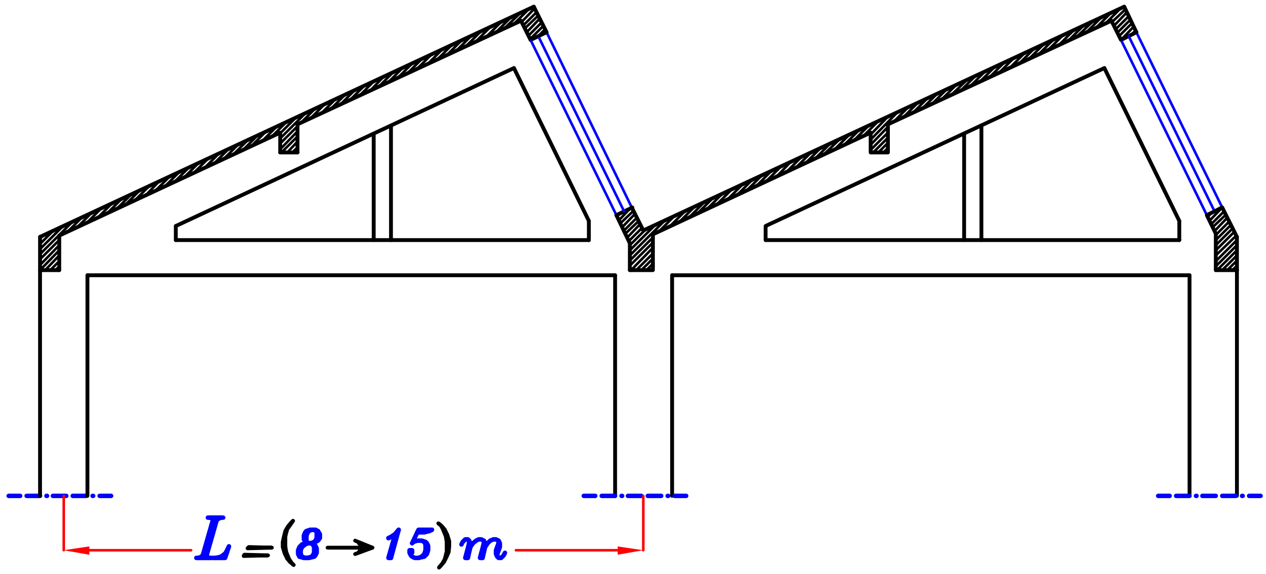
دائماً سهم الشمال خارج من الشباك

Types of Saw Tooth Structures.

① Slab Type. $L = (4 \rightarrow 8)\,m$



② Girder Type. $L = (8 \rightarrow 15)\,m$



③ Saw Tooth Supported on:

ⓐ Frames. (2 Hinged or Fixed) ---------- $L = (12 \rightarrow 24)\,m$

ⓑ Triangular Polygon Frame. -------- $L = (12 \rightarrow 16)\,m$

ⓒ Trapezoidal Polygon Frame. ------- $L = (12 \rightarrow 25)\,m$

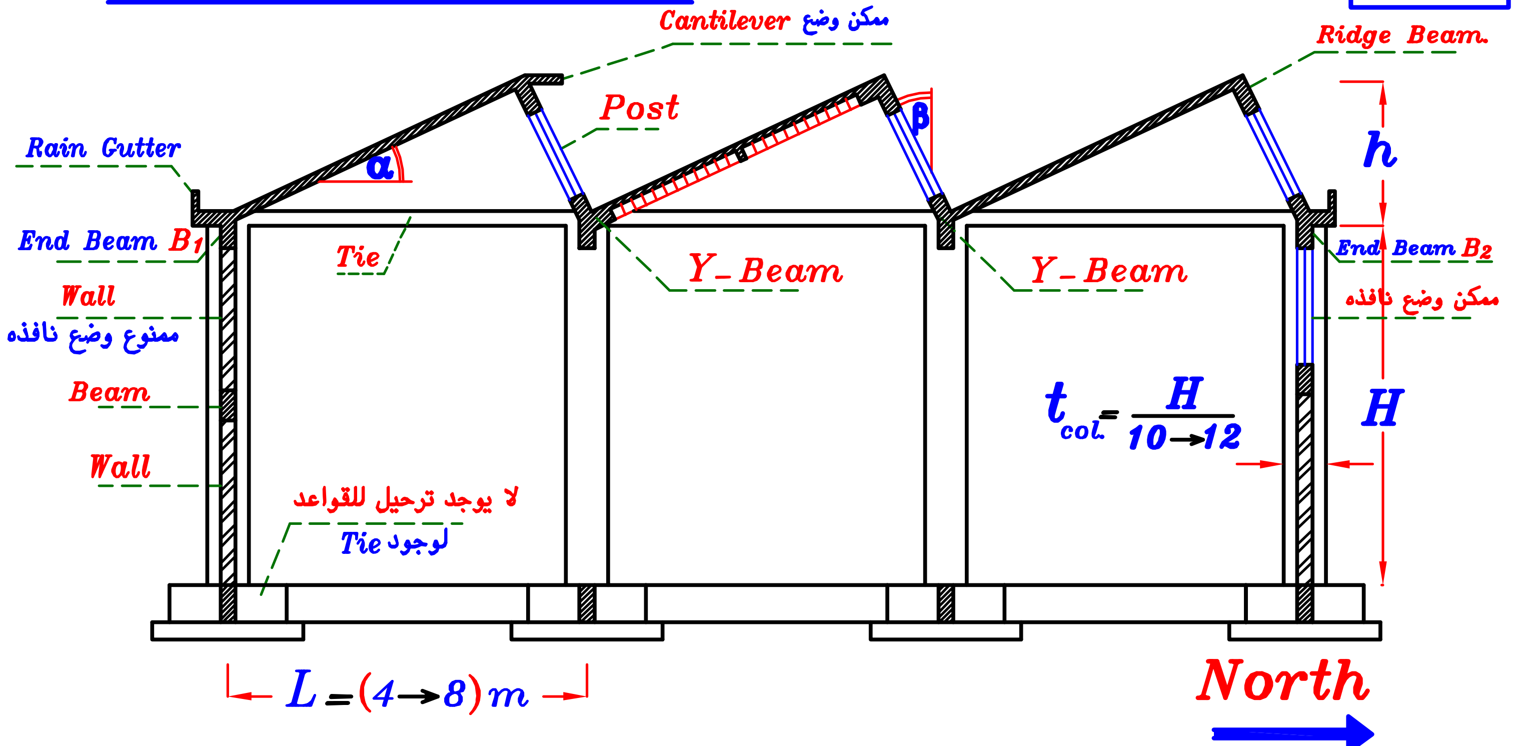
ⓓ Arch Girder ------------------------- $L = (20 \rightarrow 40)\,m$

ⓔ Truss. ------------------------------ $L = (15 \rightarrow 40)\,m$

ⓕ Vierendeel. ------------------------- $L = (15 \rightarrow 40)\,m$

Saw Tooth Slab Type.

① With Inclined Posts.



* **Span** (L) = $(4 \to 8)$ m

* **Slabs.**

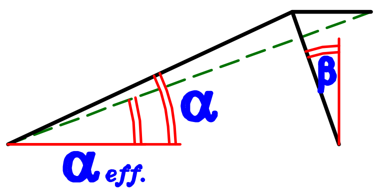
  One Way S.S. $\rightarrow$ $L \leqslant 6.0$ m

  One Way H.B. $\rightarrow$ $L = (6.0 \rightarrow 8.0)$ m

ممكن وضع Cantilever صغير فى النهايه
للتحكم فى زاويه ميل الضوء و لحمايه الزجاج
و لتقليل الـB.M.D. (+)Ve على البلاطه

* **Inclination of slab.** $(\alpha_{eff.}) = (20 \rightarrow 30^{\circ})$ مع الأفقى

* **Inclination of Post.** $(\beta) = (0 \rightarrow 15^{\circ})$ مع الرأسى



* **Tie** (300×300) يجب وضع الـ Ties لـ ١- حمل القوى الأفقيه
  ٢- تربيط الأعمده

* **Posts** (250×250)

  Distance between Posts (a) = $(2 \rightarrow 3)$ m

* **Side Beams** (250×500)

فوائدها :

١- تقلل من مساحه الحائط بحيث لا تزيد مساحته عن ٣٠ م٢ .

٢- تعمل على تربيط الأعمده فى اتجاه Out of plane .

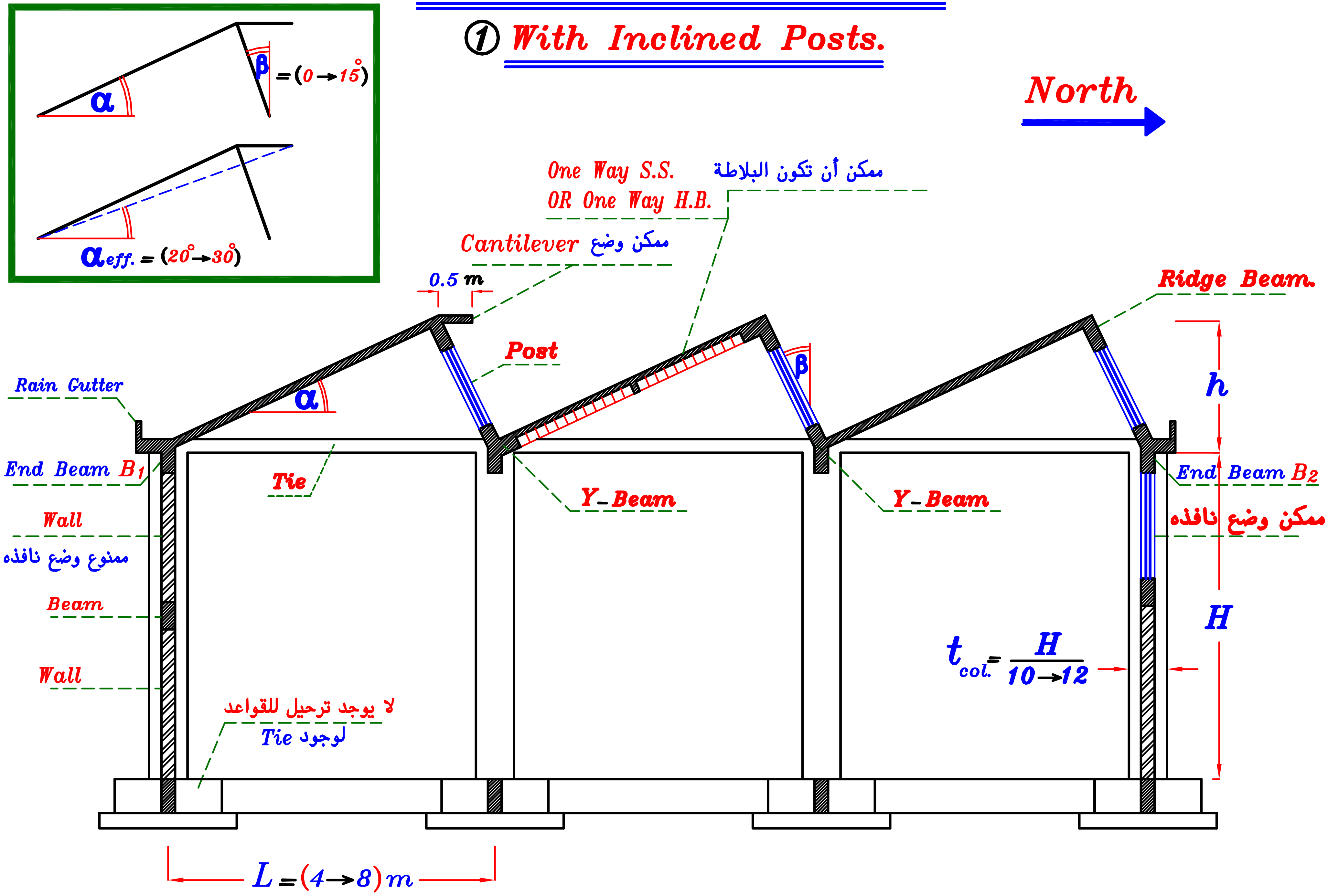
* **Smell** طول السمله لا يزيد عن ١٠,٠ م

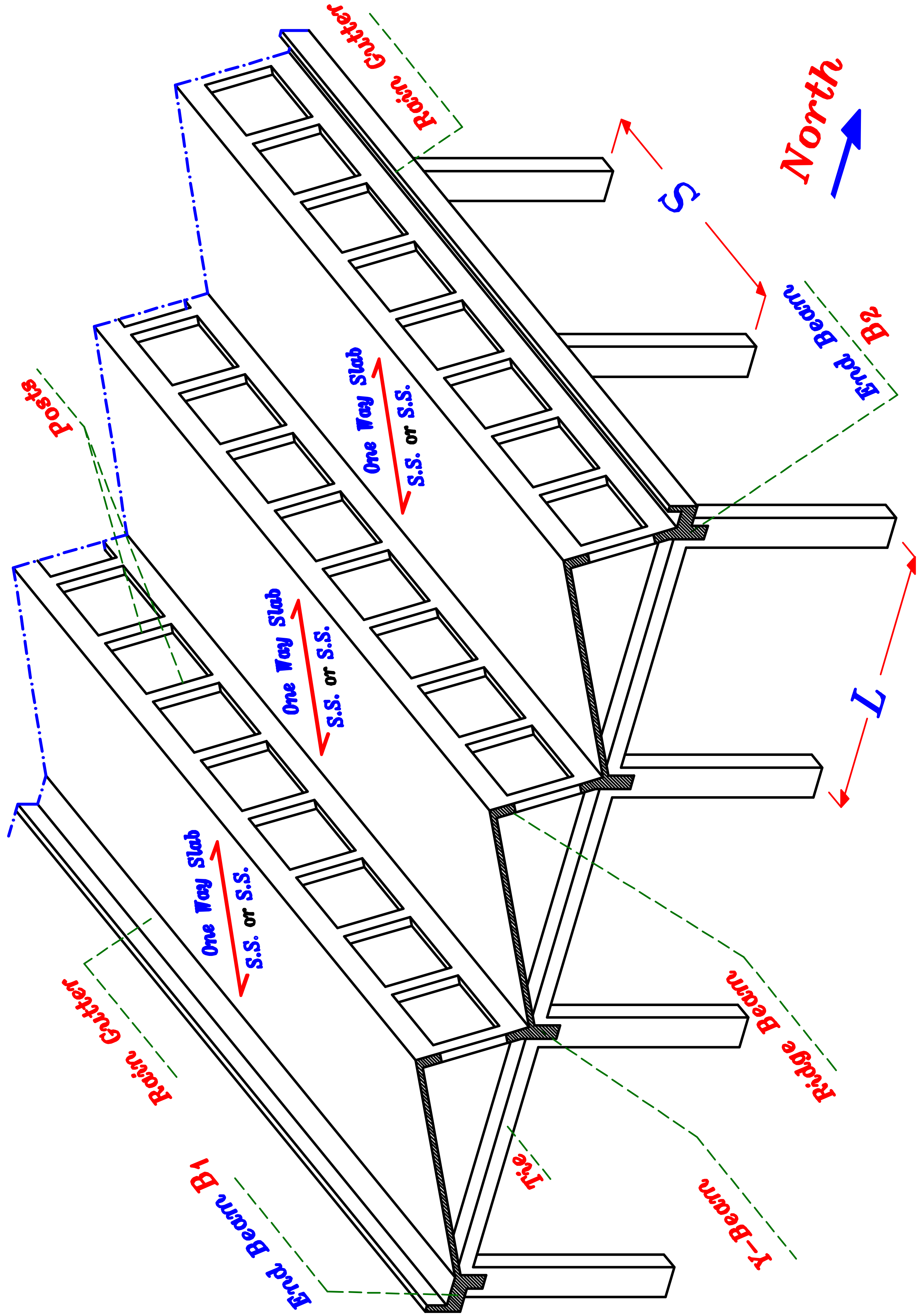
نضع مخدات من الخرسانه العاديه إذا زاد طول السمله عن ٧,٠ م

* $t_{col.} = \frac{H}{10 \rightarrow 12}$

Saw Tooth Slab Type.

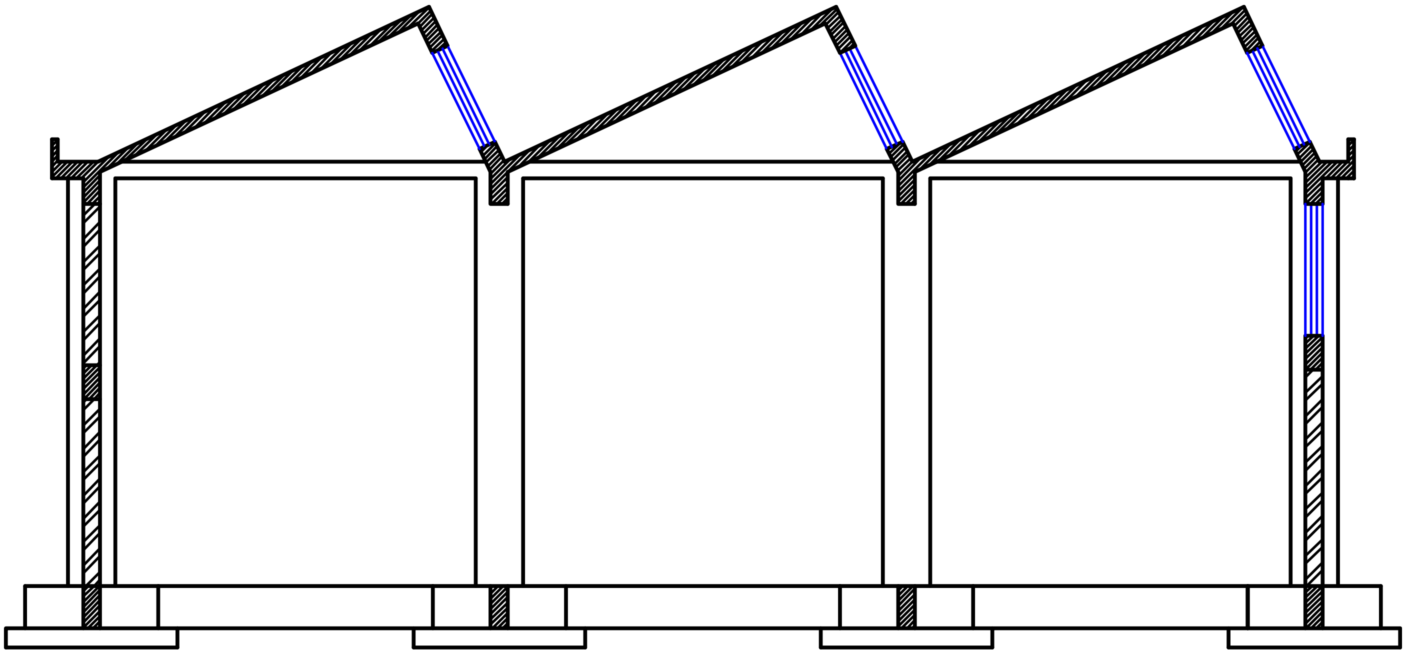
① With Inclined Posts.



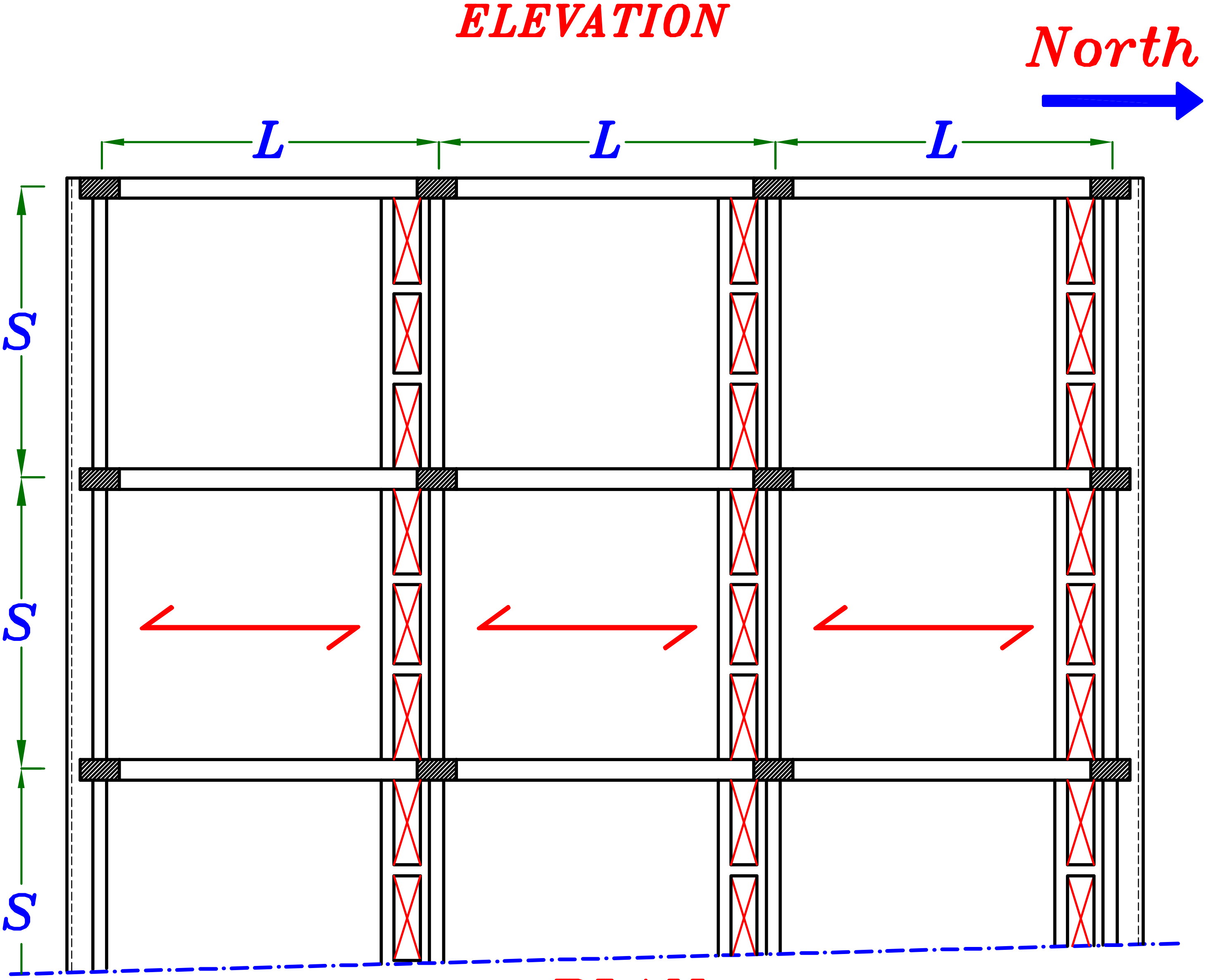

North
S
L
Rain Gutter
Rain Gutter
End Beam B2
End Beam B1
Posts
One Way Slab
S.S. or S.S.
One Way Slab
S.S. or S.S.
One Way Slab
S.S. or S.S.
Ridge Beam
Tie
Y-Beam

Saw Tooth Slab Type

Solid Slab $L \leqslant 6.0\,m$

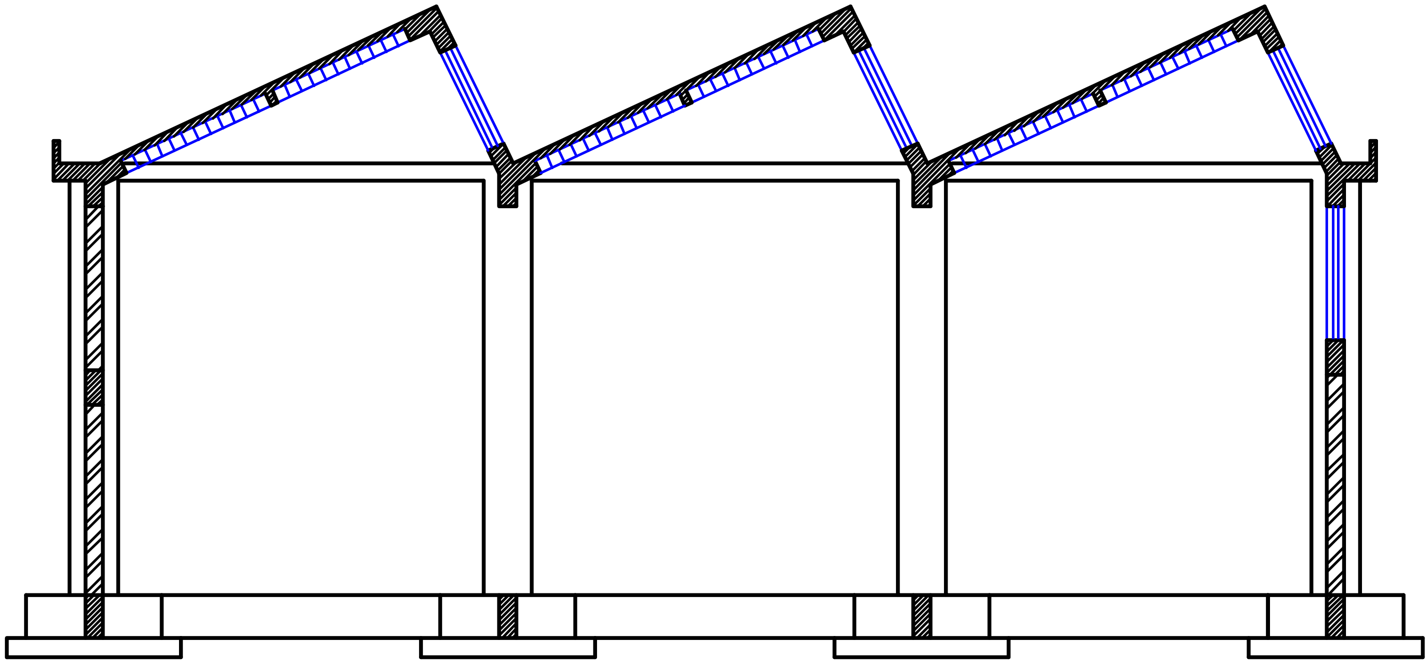


ELEVATION

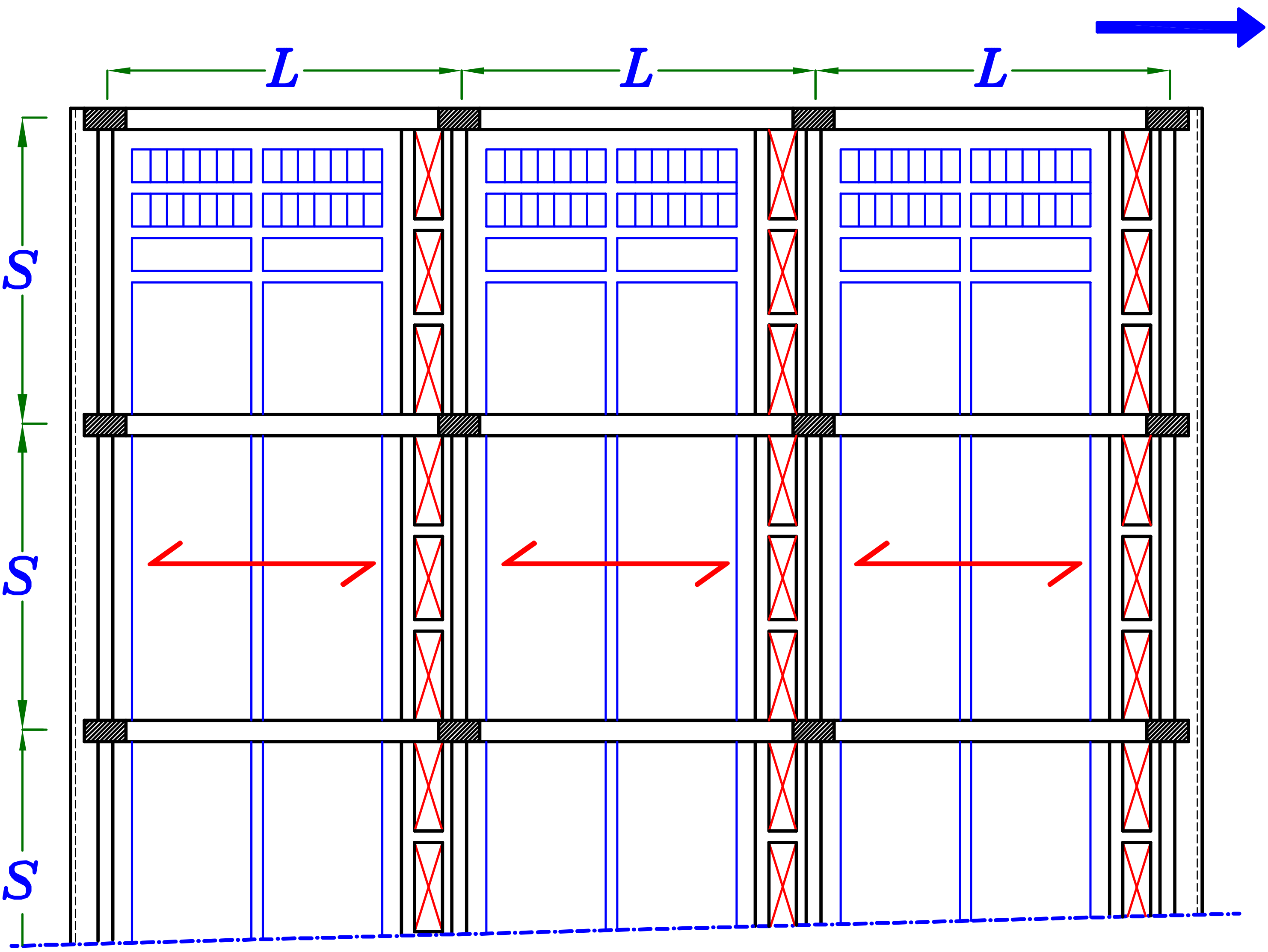


PLAN

Saw Tooth Slab Type H.B. Slab $L > 6.0\,m$



ELEVATION



PLAN

Design of Slab.

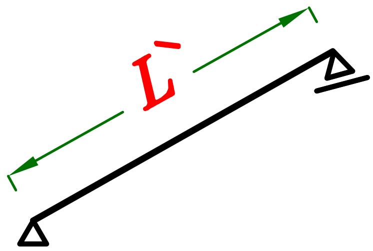
One Way S.S. $\rightarrow$ $L \leqslant 6.0$ m

One Way H.B. $\rightarrow$ $L = (6.0 \rightarrow 8.0)$ m

– Calculate t_s

For Solid or Hollow Blocks Slabs

we can take $\boxed{t_s = \dfrac{L`}{30 \rightarrow 35}}$



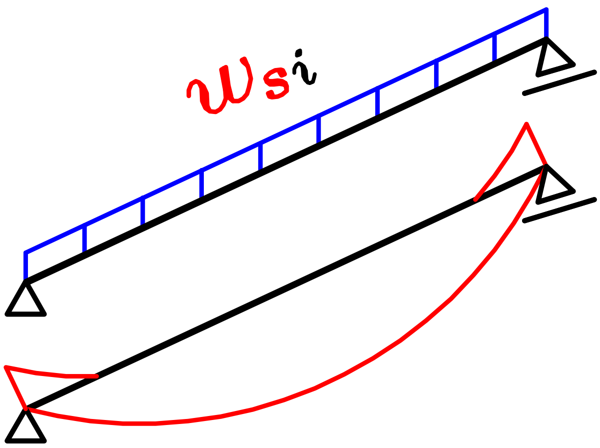
لان البلاطه مائله لاعلى فبالتالى ال L.L. يكون صغير فيكون ال deflection قليل .

– Calculate w_s For S.S.

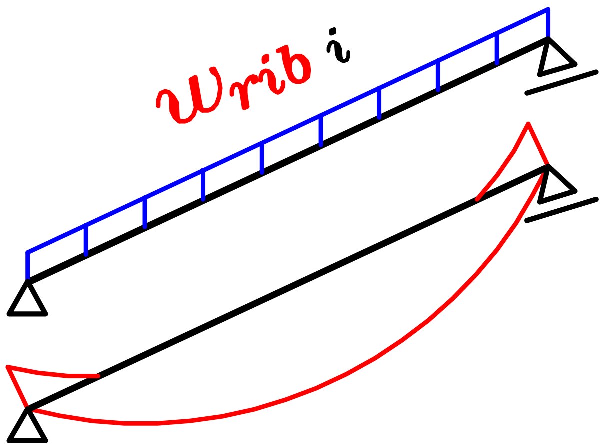
w_{rib} For H.B.

– Take a strip at Load direction

For S.S.

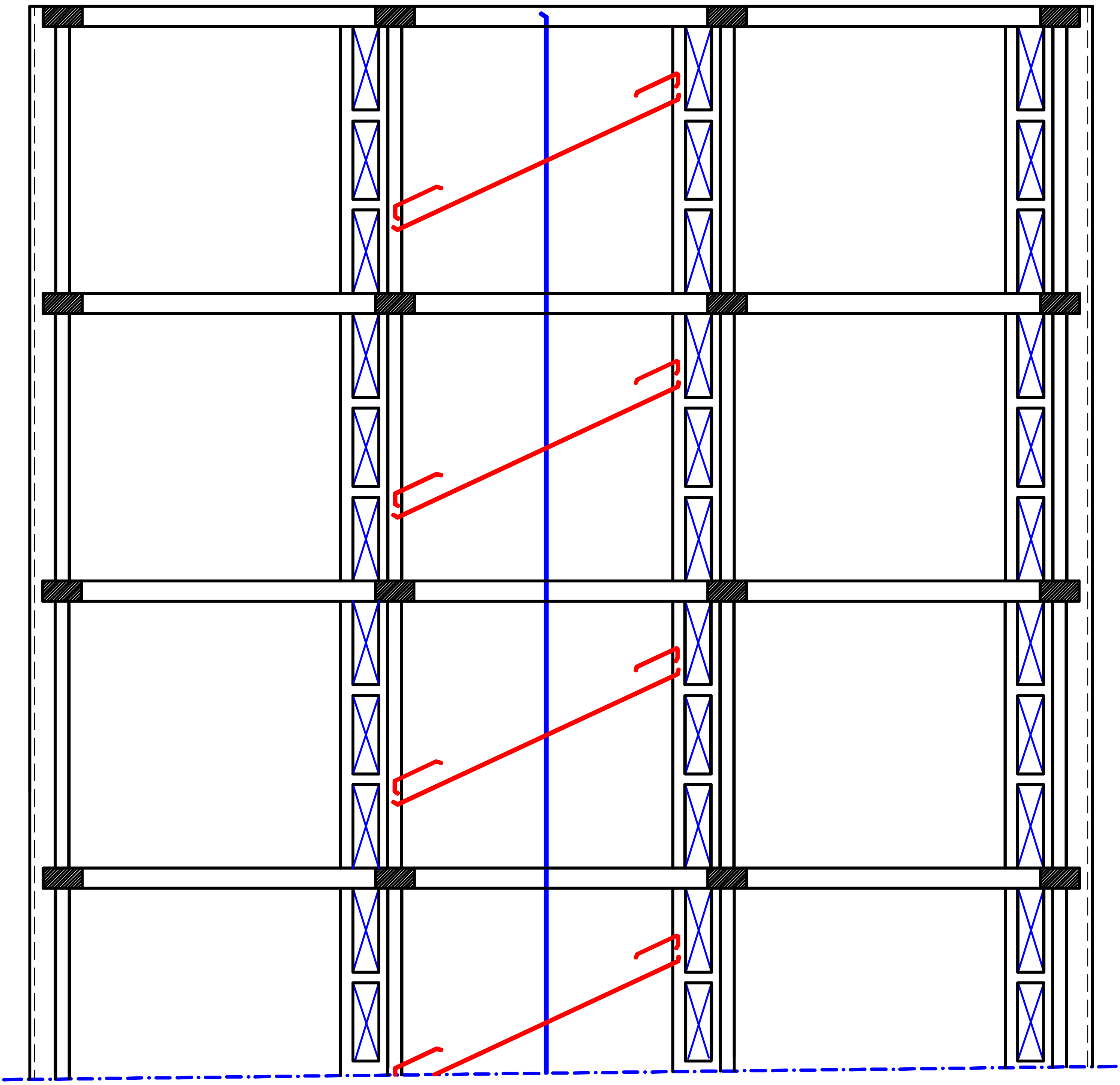


For H.B.

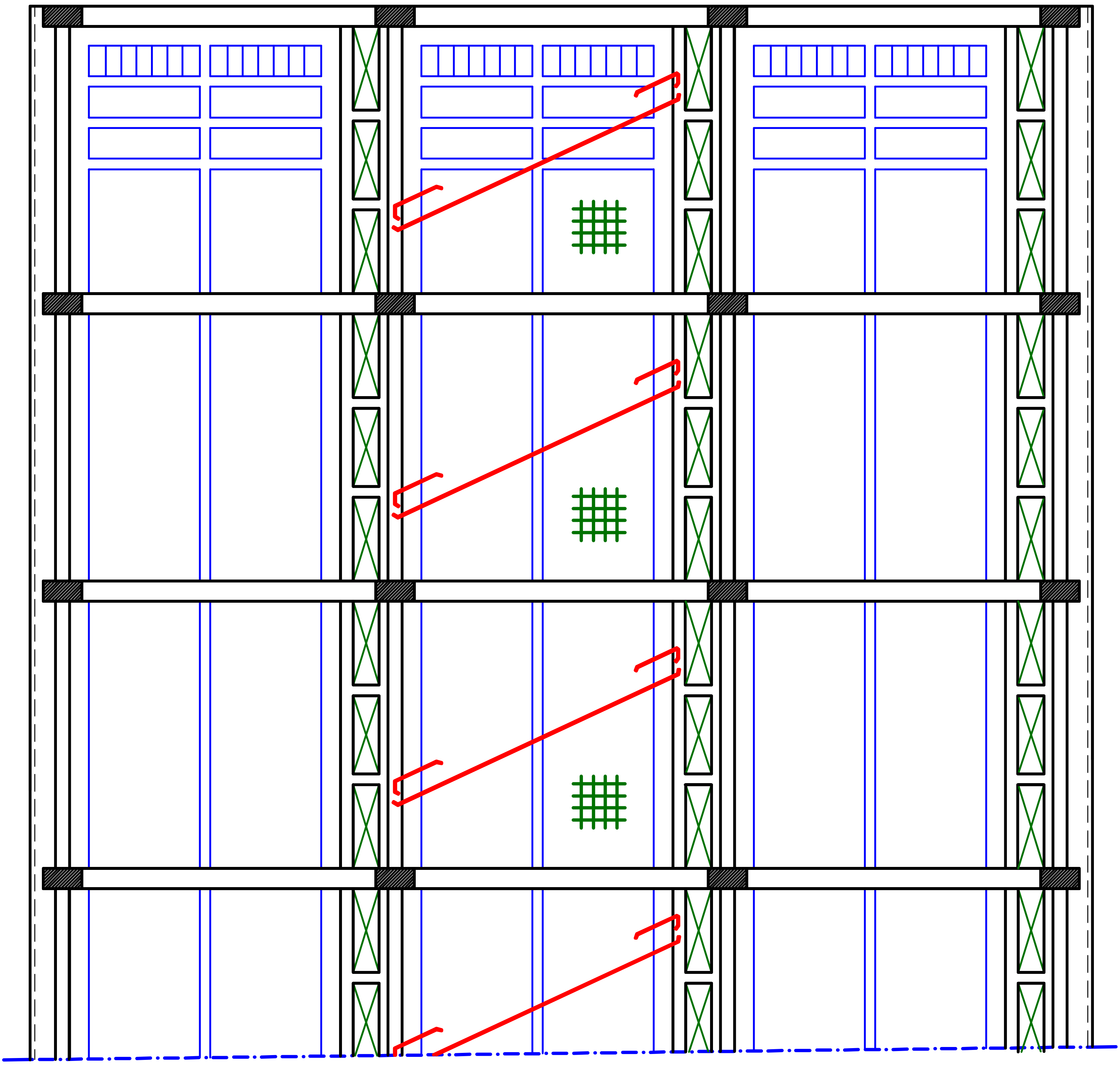


– Design the strip and get the RFT.

RFT. of the slab Solid Slab.

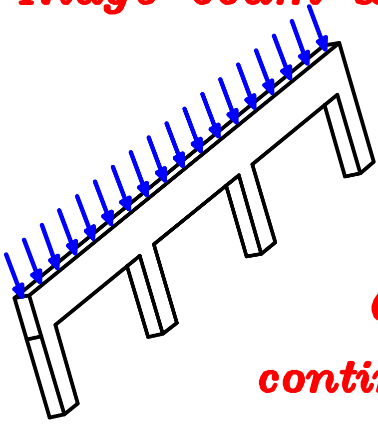


RFT. of the slab H.B. Slab.

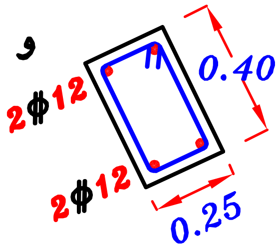


Analysis of Loads.

- ينتقل الحمل من البلاطه الى كمرتين ***Ridge beam & Y-beam***

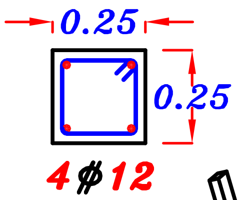


- اذا كان الـ ***post*** مائل نأخذ الـ ***Ridge beam*** مائله بنفس ميل الـ ***post*** حتى تحول الاحمال فى نفس اتجاهه . ***axial load***
- يتكرر الـ ***post*** كل مسافه $a = (2.0 \rightarrow 3.0\,m)$ لذا تكون الكمره الـ ***Ridge beam*** كمره ***continuous*** و لكنها عاده تؤخذ ***min***

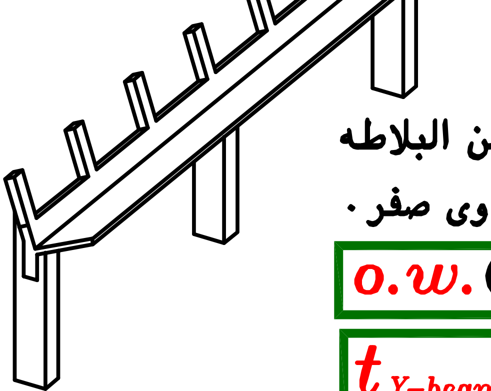


$$\boxed{o.w.\,(\text{Ridge Beam}) = 4.2\ kN/m\ U.L.}$$

- ينتقل الحمل من الـ ***Ridge beam*** الى الـ***post*** و عاده يؤخذ ***min***



$$\boxed{o.w.\,(\text{Post}) = 3.5\ kN\ U.L.}$$

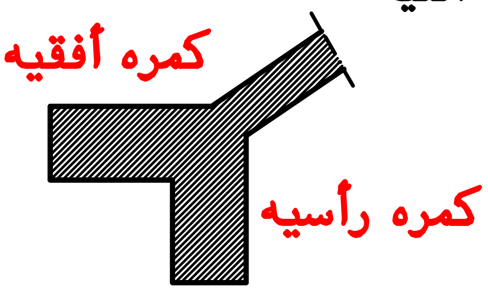


- ينتقل الحمل من الـ ***post*** الى الـ ***Y-beam*** و تكون الـ ***Y-beam*** كمره ***continuous*** تحمل احمال مركزه من الـ ***post*** و أحمال منتظمه من البلاطه و تكون محصله القوى الافقيه على الـ ***Y-beam*** تساوى صفر .

$$\boxed{o.w.\,(\text{Y-Beam}) = b\,t\,\gamma_c * 1.4\ kN/m\ U.L.}$$

$$\boxed{t_{Y\text{-}beam} \simeq \frac{Spacing}{12} + 150\ mm}$$

- الكمره الطرفيه ***End beam*** يوجد عليها مركبه أفقيه اذا كان الـ ***post*** مائل لذا تتكون من كمرتين كمره رأسيه لتحمل الاحمال الرأسيه كمره أفقيه لتحمل الاحمال الافقيه .



$$\boxed{t_{H.L.} \simeq t_{V.L.} \simeq \frac{Spacing}{12}}$$

$$\boxed{o.w.\,(\text{End Beam VL + HL}) = 7.0\ kN/m\ U.L.}$$

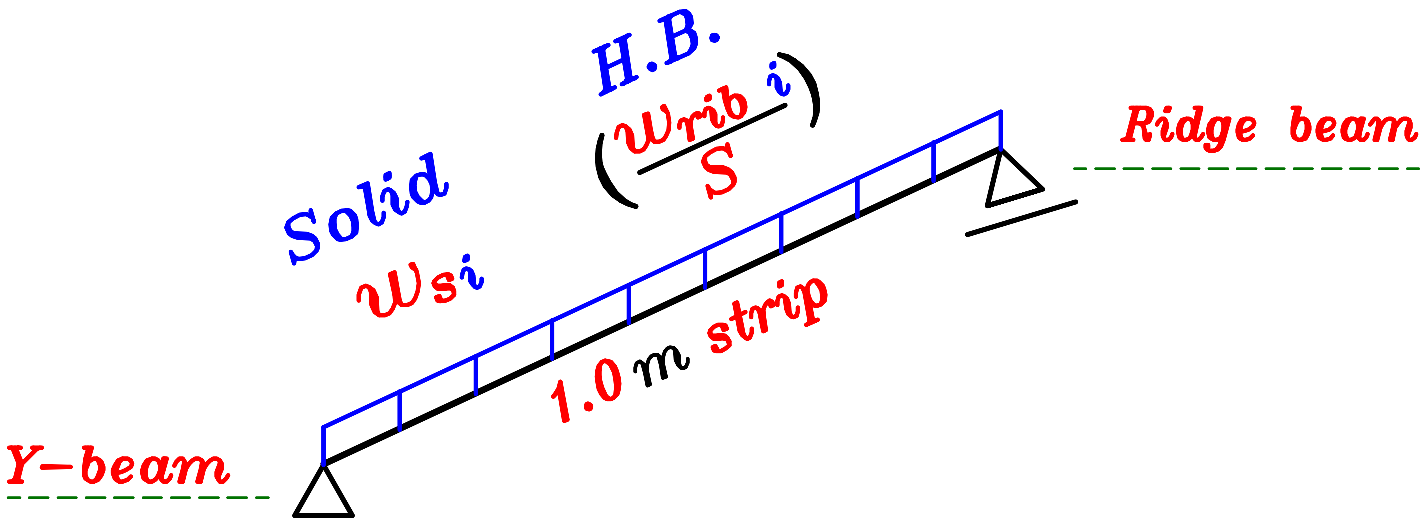
Steps of Design.

① Loads From Slab.

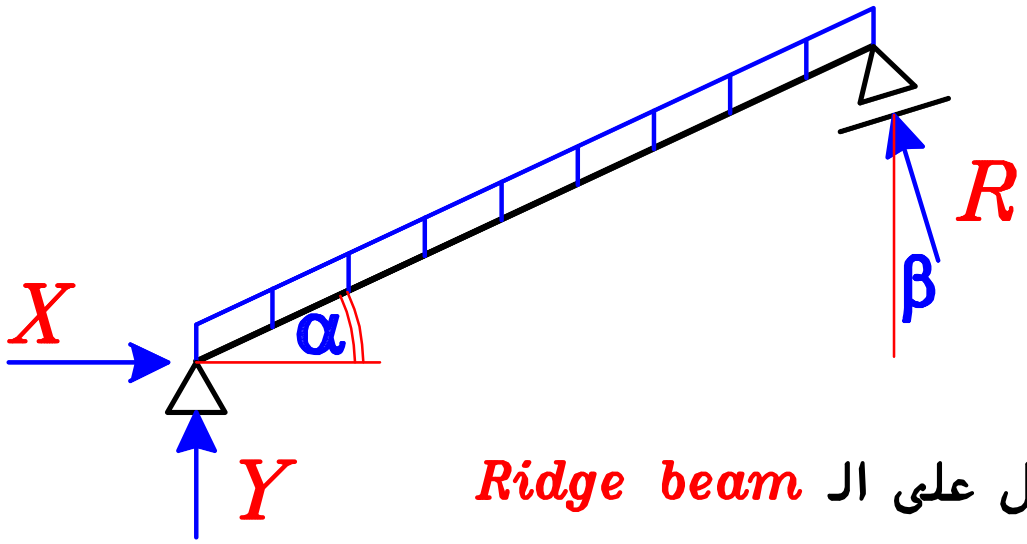
نأخذ شريحه فى البلاطه عرضها ١,٠ م

مع اعتبار ال *Y-beam* كأنها *hinged support*

و اعتبار ال *Ridge beam* كأنها *Roller support* مائل بنفس ميل ال *post*



نحدد *Reactions* شريحه البلاطه .

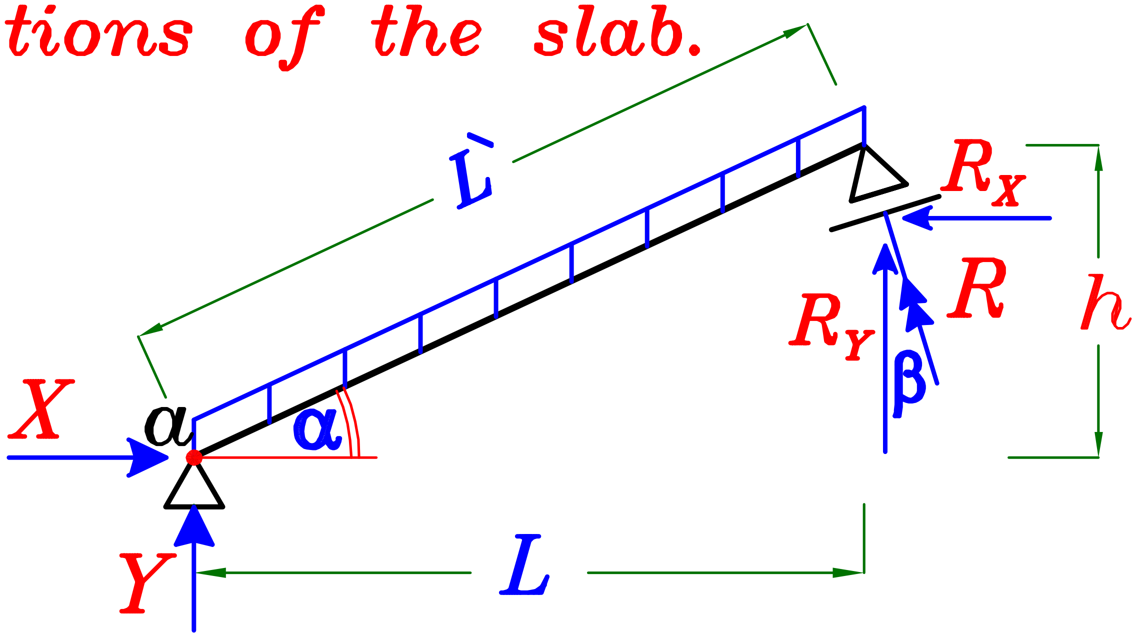


حيث *R* ينتقل على ال *Ridge beam*

حيث *X , Y* ينتقلا على *Y-beam*

ملحوظه *R , X , Y* يعتبروا أحمال منتظمه على الكمرات لانها *Reactions* لشريحه بلاطه عرضها ١,٠ م

Reactions of the slab.



Using Equations.

$$R_Y = R\ Cos\,\beta$$

$$R_X = R\ Sin\,\beta$$

$$\because \sum M_a = Zero$$

$$w_s\ L`\left(\frac{L}{2}\right) - R_Y\,(L) - R_X\,(h) = 0.0$$

$$\therefore\ w_s\ L`\left(\frac{L}{2}\right) - R\ Cos\,\beta\,(L) - R\ Sin\,\beta\ (h) = 0.0$$

Get $R = \checkmark$

$$\therefore\ R_Y = R\ Cos\,\beta\ = \checkmark$$

$$\therefore\ R_X = R\ Sin\,\beta\ = \checkmark$$

$$\therefore\ X = R_X\ = \checkmark$$

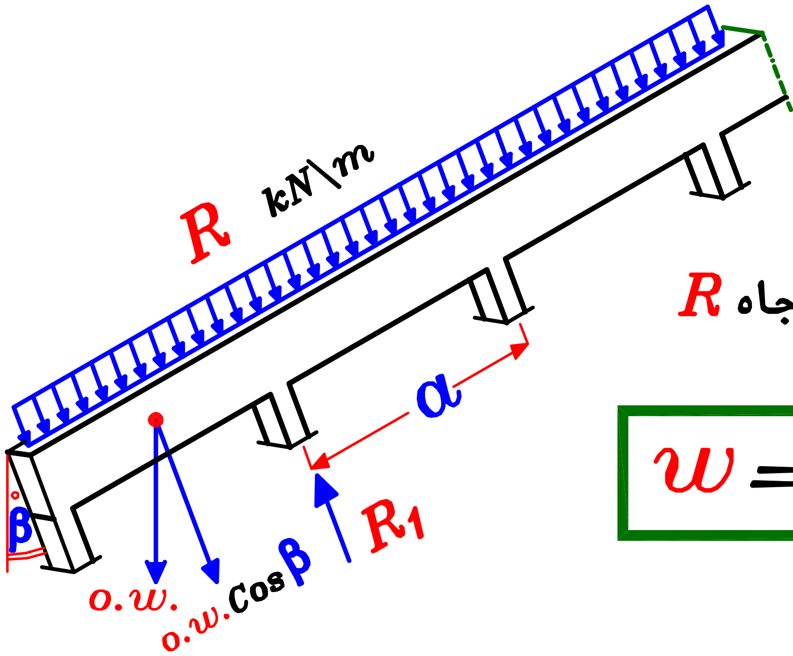
Get Y From $\sum y = Zero \longrightarrow$ Get $y = \checkmark$

Ridge Beam.

- الكمره ال Ridge beam كمره continuous
محموله على post يتكرر كل مسافه $a = (2.0 \rightarrow 3.0\,m)$

- اذا كان ال post مائل نأخذ ال Ridge beam مائله بنفس ميل ال post
حتى تحول الاحمال فى نفس اتجاهه (axial load on the post)

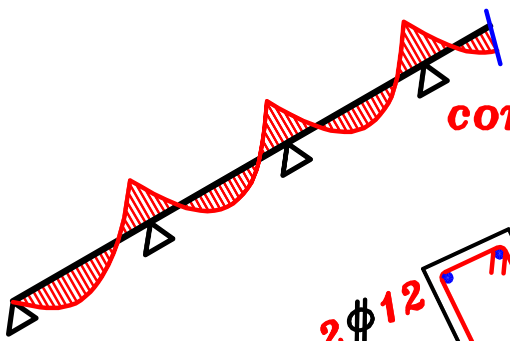
- تحمل ال Ridge beam حمل منتظم من البلاطه قيمته R



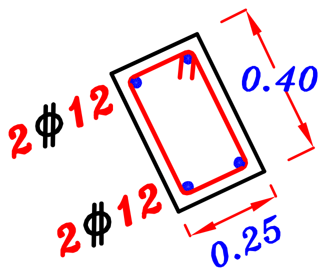
اذا كان ال post مائل
نحلل وزن الكمره الى المركبه
المائله حتى تكون فى نفس اتجاه R

$$\boxed{w = o.w\,Cos\,\beta + R}$$

و عاده نأخذ o.w. الكمره = $3.0 * 1.4 = 4.2$ kN/m



- لان الكمره ال Ridge beam كمره continuous
بحرها صغير جدا $(2.0 \rightarrow 3.0\,m)$
اذا بدون تصميم سوف نأخذ الكمره min



- Reaction الكمره يحمل على ال post

$$\boxed{R_1 = w * a}$$

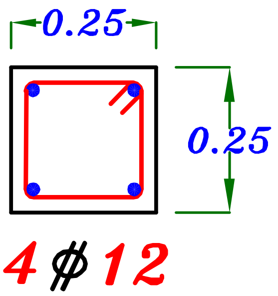
Post.

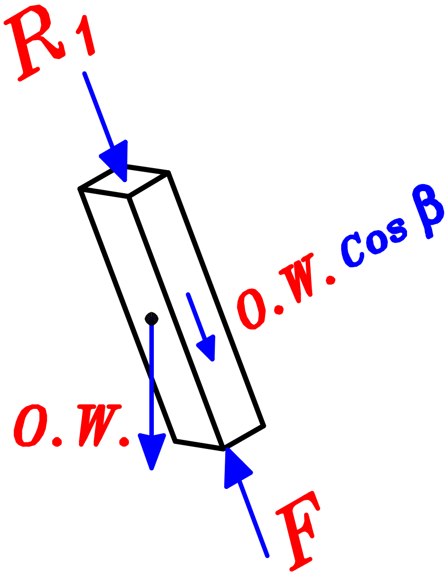
- ينتقل الحمل من ال *Ridge beam* الى ال *post*
نحلل وزن ال *post* حتى يكون فى نفس اتجاه R_1

$$F = O.W._{(Post)} * \cos\beta + R_1$$

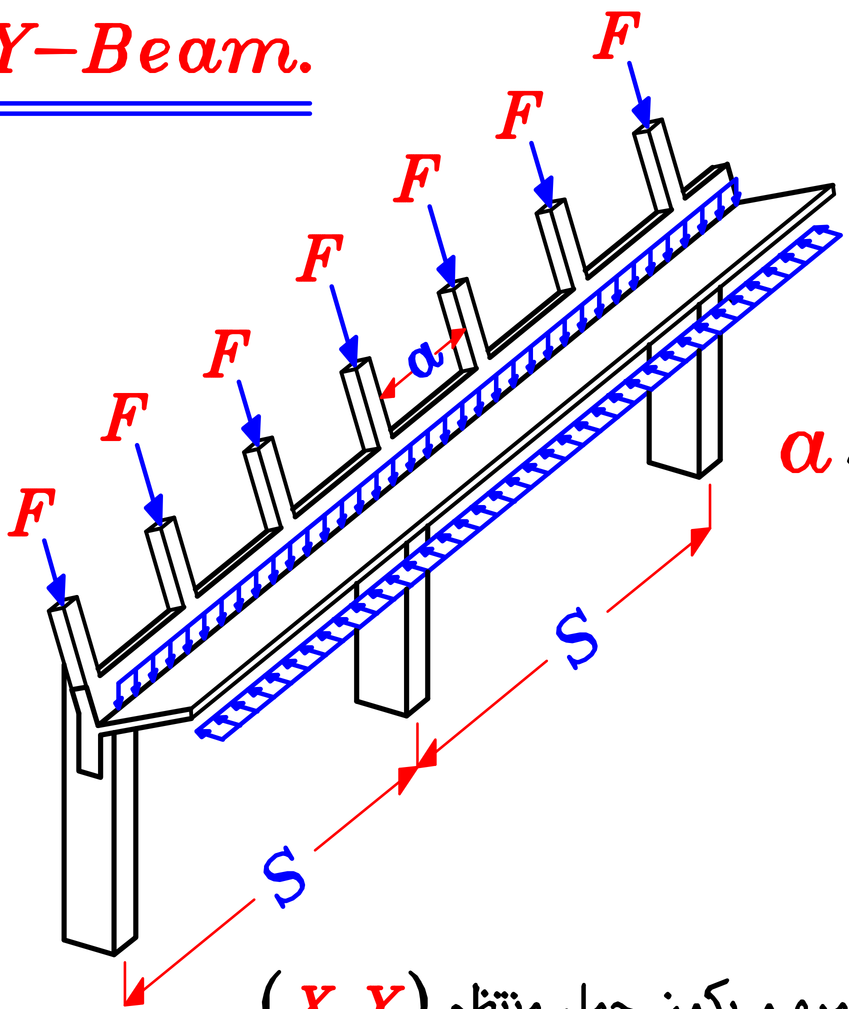
$$O.W._{(Post)} \simeq 3.50\ kN\ (U.L.)$$

عاده يؤخذ ال *post*





Y-Beam.



- الكمره ال *Y-beam*
كمره *continuous*

- ينتقل الحمل F من ال *post*
الى ال *Y-beam* و تكون
أحمال مركزه تتكرر كل مسافه a

- يتم تحليل الحمل F
الى مركبتين F_X & F_Y

$$\boxed{\begin{aligned} F_Y &= F\ \cos\beta \\ F_X &= F\ \sin\beta \end{aligned}}$$

- ينتقل الحمل من البلاطه الى الكمره و يكون حمل منتظم (X, Y)
و تكون محصله القوى الافقيه على ال *Y-beam* تساوى صفر .

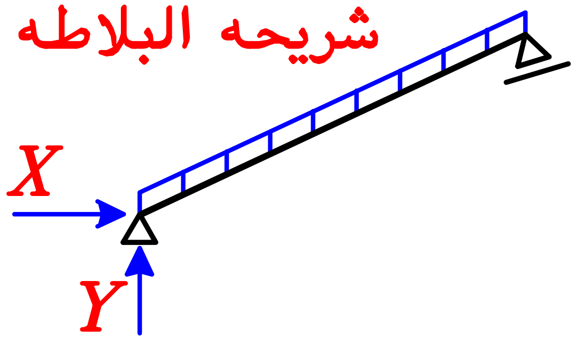
Distributed Loads.

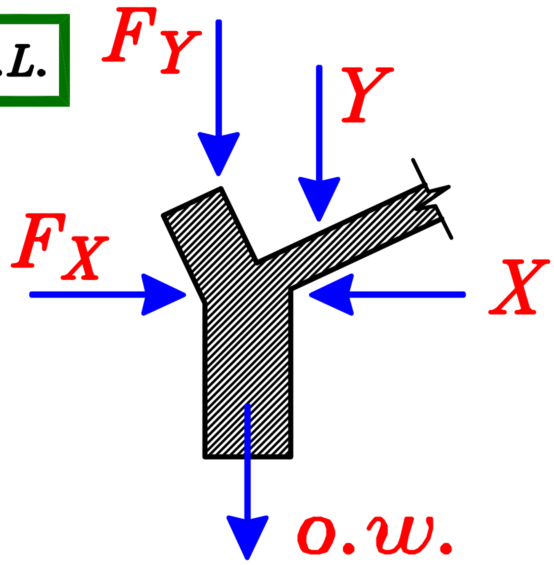
$$t_{Y\text{-beam}} \simeq \frac{Spacing}{12} + 150\ mm$$

$$o.w.(Y\text{-Beam}) = b\ t\ \gamma_c * 1.4\ kN/m\ U.L.$$

X, Y From slab.

شريحه البلاطه



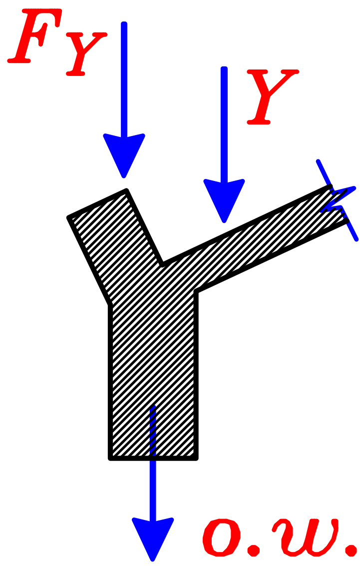


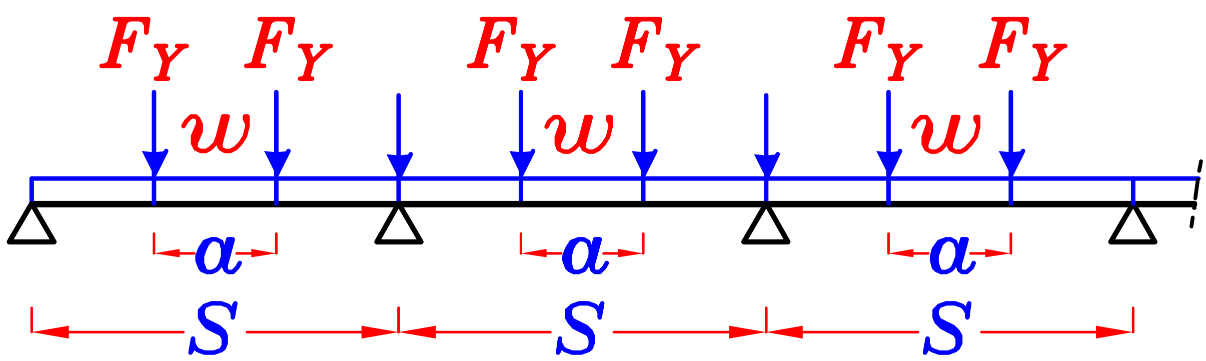
Concentrated Loads.

F_X, F_Y From post

F_X تساوى محصله X محصله

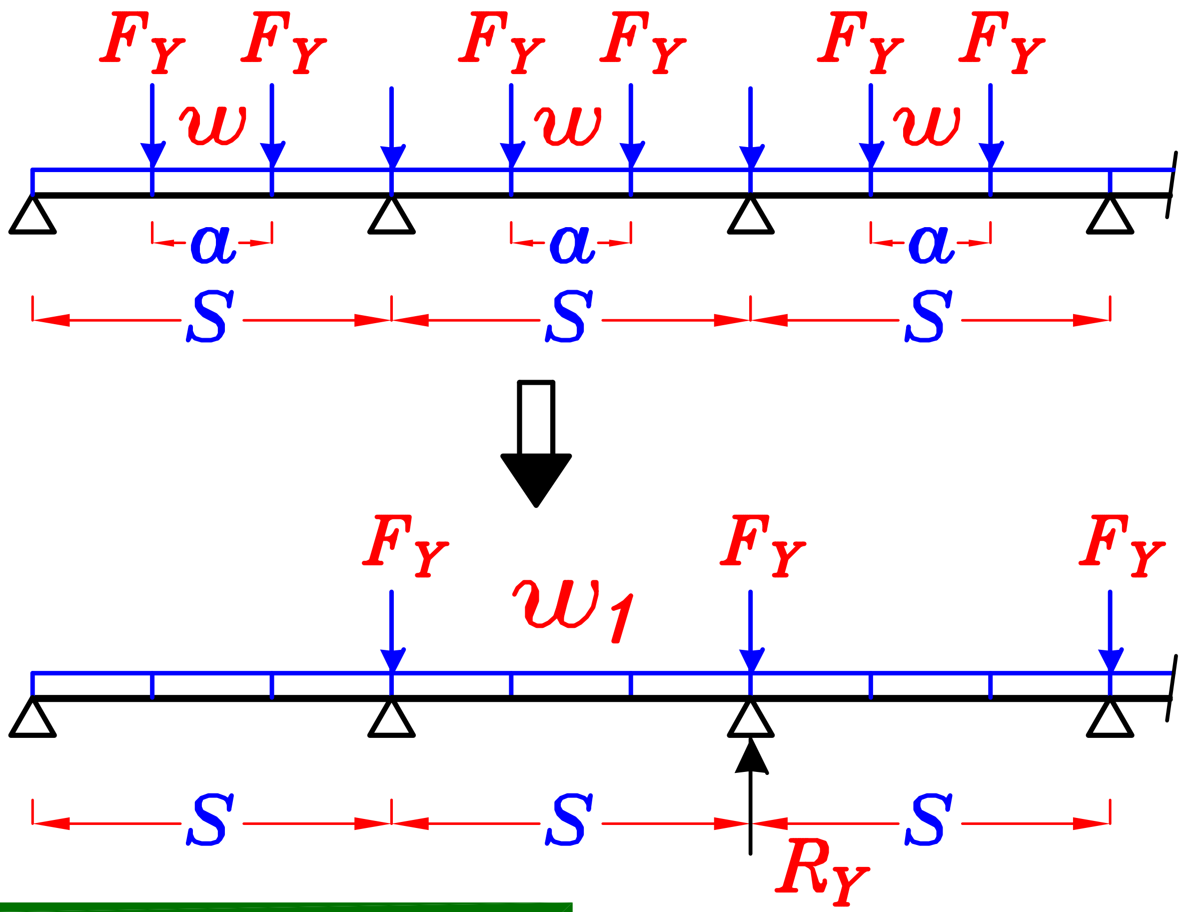
$$\Sigma X = zero$$





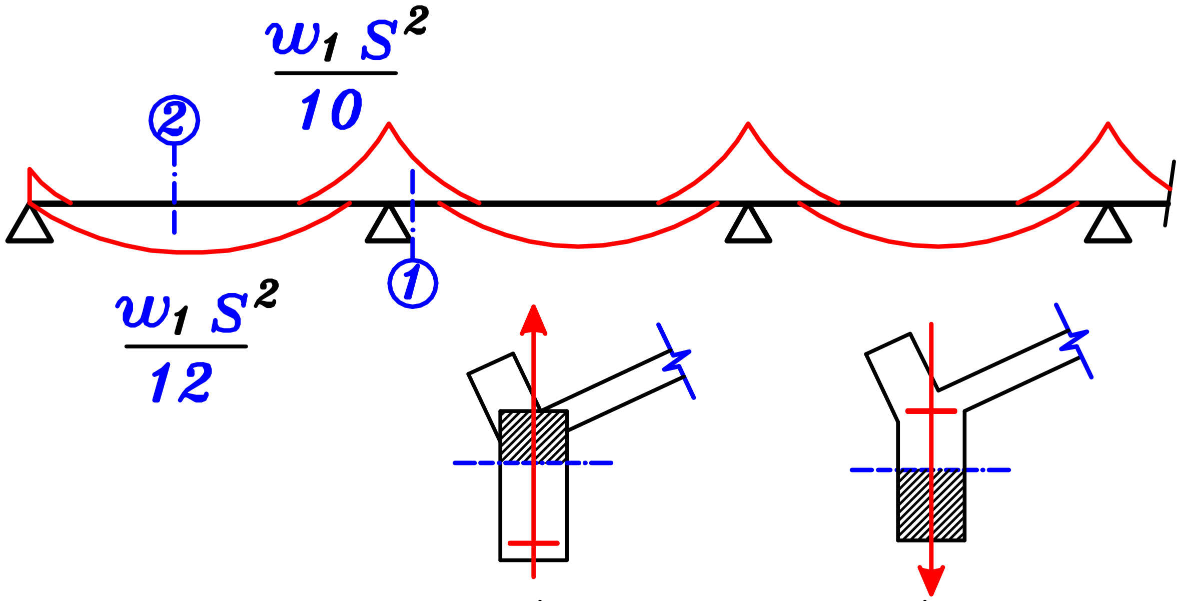
$$\boxed{w = o.w. + Y}$$

لتسهيل حل الكمره الـ *Y−beam* نعمل حل تقريبى
و ذلك بتحويل الاحمال المركزه الى أحمال منتظمه .



$$\boxed{w_1 = w + \frac{\Sigma\, F_Y}{S}}$$

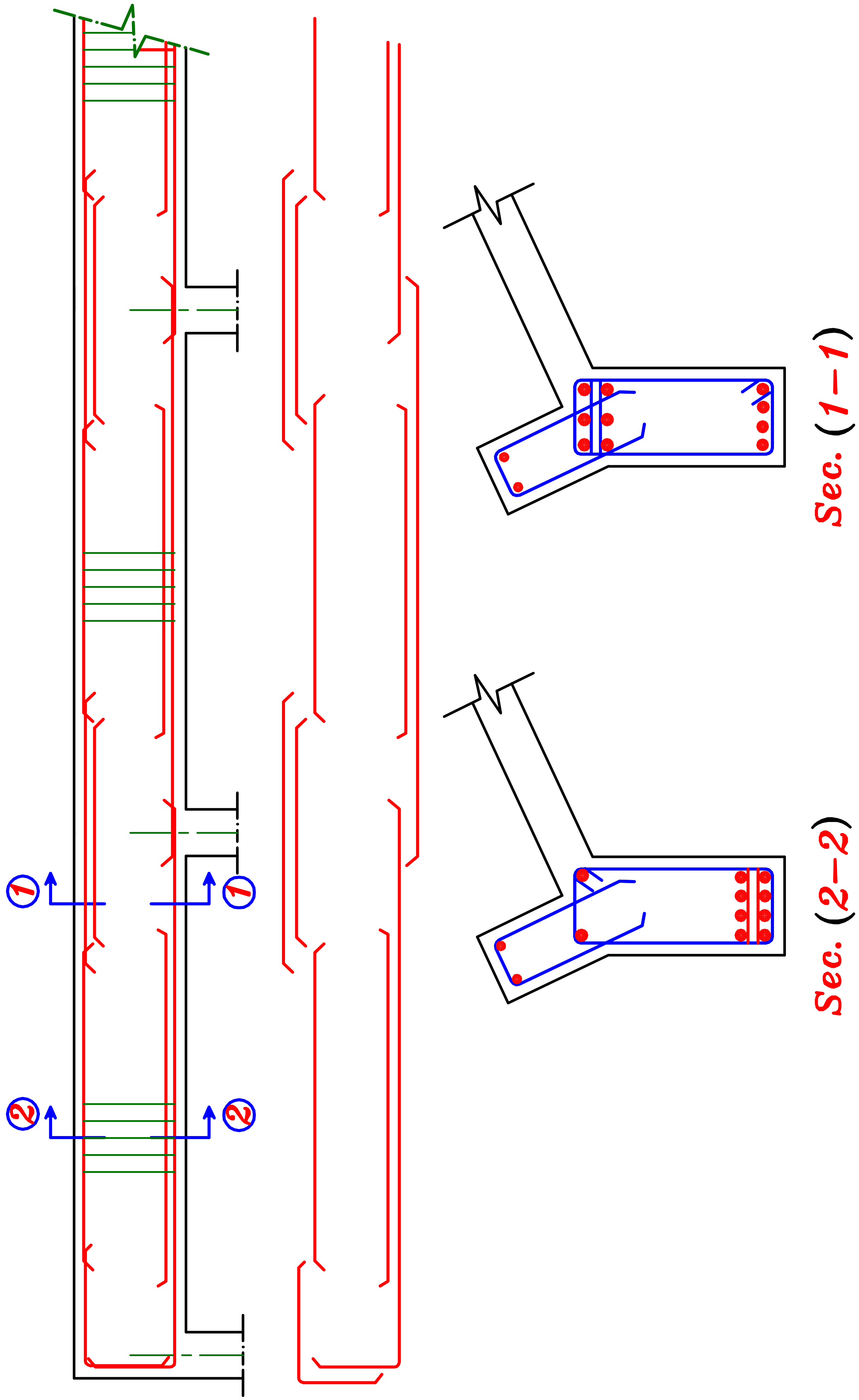
$$\boxed{R_Y = w_1 * S + F_Y}$$



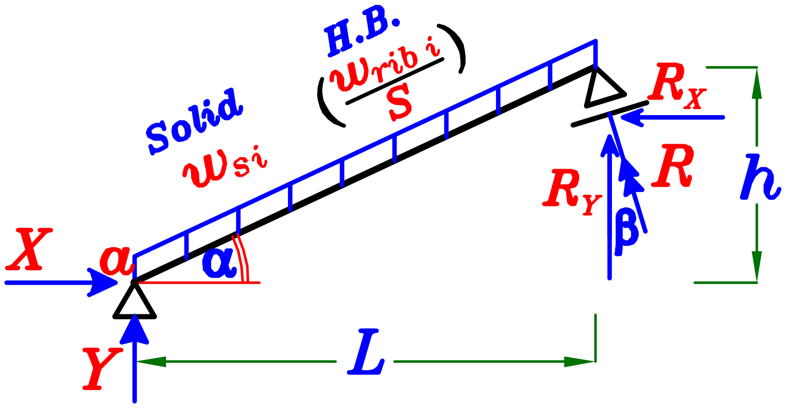
Sec. (2−2)
R−sec.

Sec. (1−1)
R−sec.

RFT. of Y-Beam.



خطوات تصميم $Y-Beam$ الشباك مائل



نأخذ شريحه فى البلاطه عرضها ١,٠ م

و نحدد ال $Reactions\ R, X, Y$

$$\boxed{w = R + o.w \cos\beta}$$

$$\boxed{R_1 = w * a}$$

Ridge Beam

$$\boxed{F = R_1 + o.w \cos\beta}$$

$$\boxed{F_Y = F \cos\beta}$$

Post

$$\boxed{w_1 = o.w + Y + \frac{\Sigma F_Y}{S}}$$

$$\boxed{R_Y = w_1 * S + F_Y}$$

Y–Beam

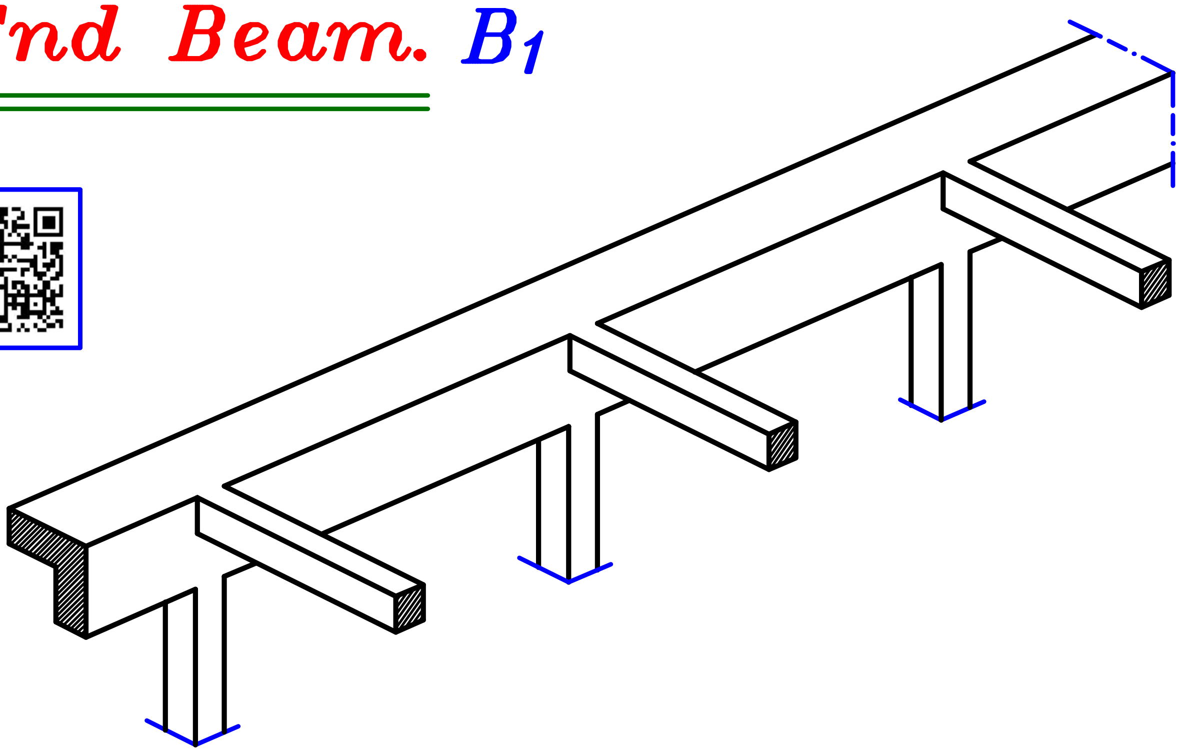
$o.w.$ (Ridge Beam) $= 4.2$ kN/m U.L.

$o.w.$ (Post) $= 3.5$ kN U.L.

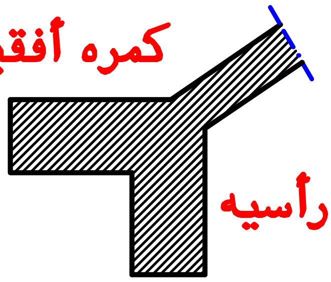
$o.w.$ (Y-Beam) $= b\,t\,\gamma_c * 1.4$ kN/m U.L.

$$\boxed{t_{Y\text{-}beam} \simeq \frac{Spacing}{12} + 150\ mm}$$

End Beam. B_1



- الكمره الطرفيه **End beam** يوجد عليها قوه أفقيه

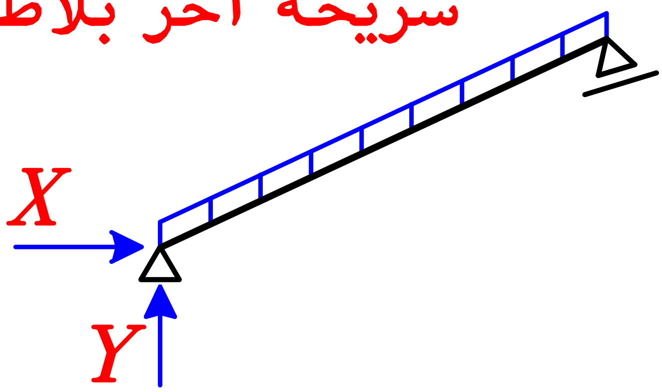


اذا كان ال **post** مائل لذا تتكون من كمرتين
كمره رأسيه لتحمل الاحمال الرأسيه
و كمره أفقيه لتحمل الاحمال الافقيه .

- أى قوى رأسيه تذهب الى الكمره الرأسيه
أى قوى أفقيه تذهب الى الكمره الافقيه .

- وزن الكمرتين هو حمل رأسى لذا يذهب الى الكمره الرأسيه فقط.

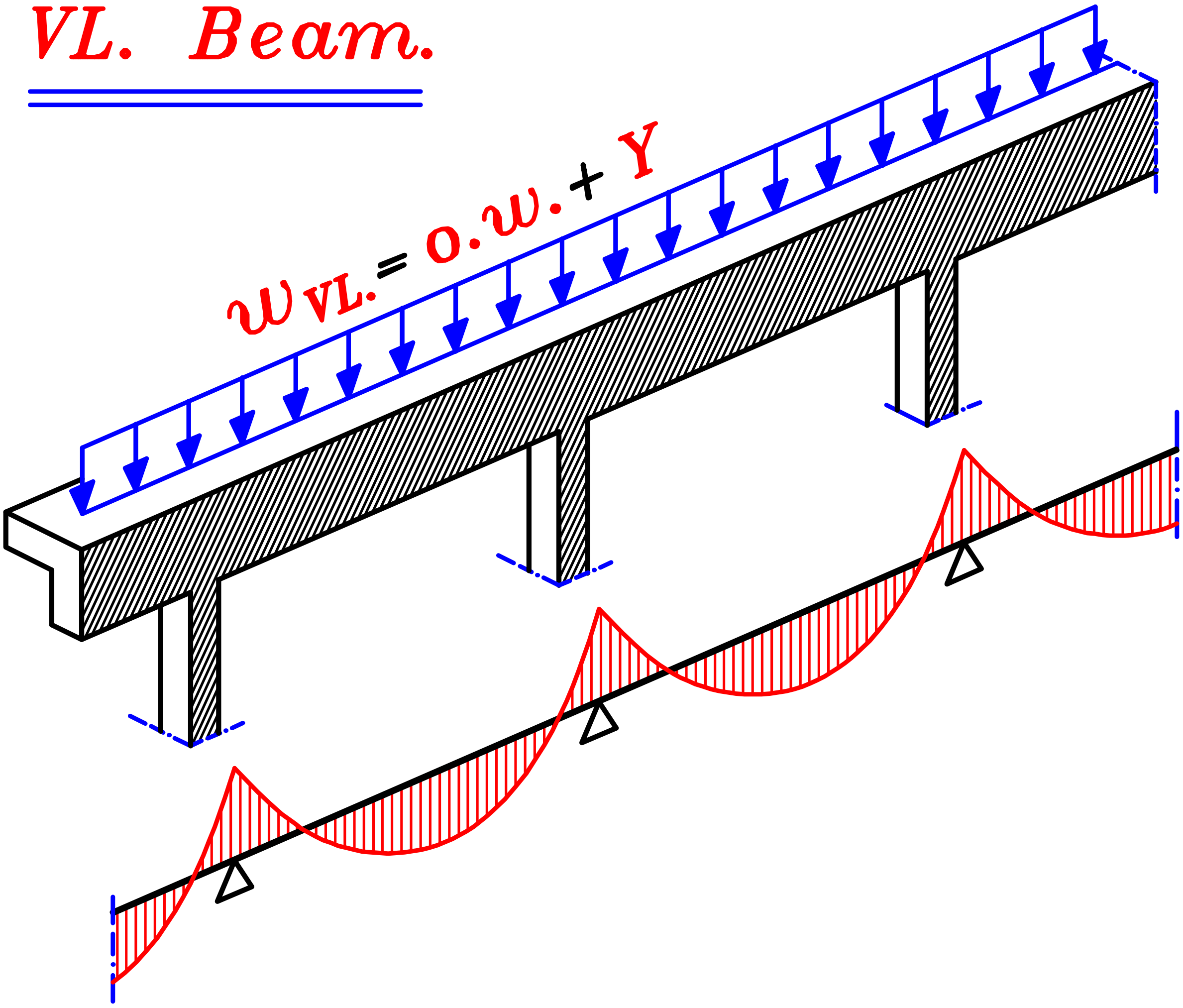
$$\underset{(beam)}{O.W.} \ (VL.+HL.) \simeq 7.0 \ kN/m$$



- X,Y من أخر بلاطه تذهب
على ال **End beam**

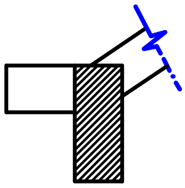
Y تذهب الى الكمره الرأسيه .
X تذهب الى الكمره الافقيه .

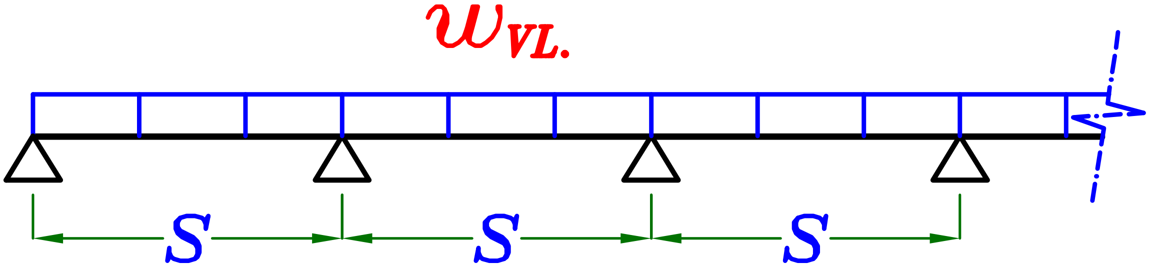
VL. Beam.

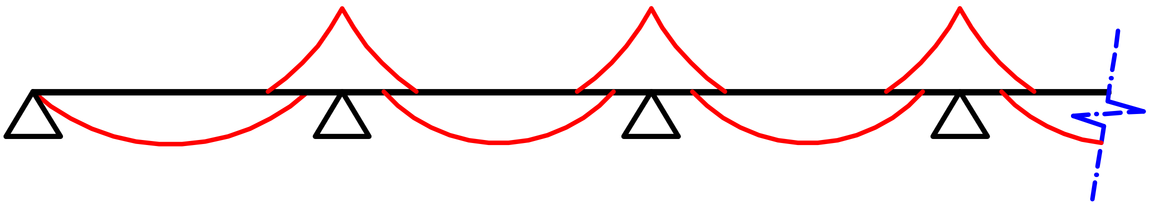


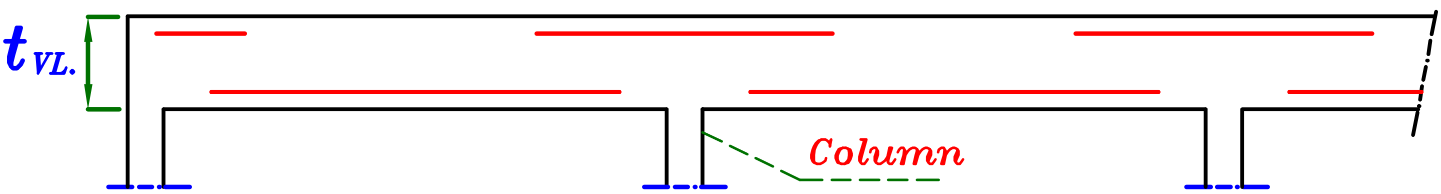
$$w_{VL.} = O.W._{(beam)} + Y \quad kN\backslash m`$$

Designed as R–Sec.

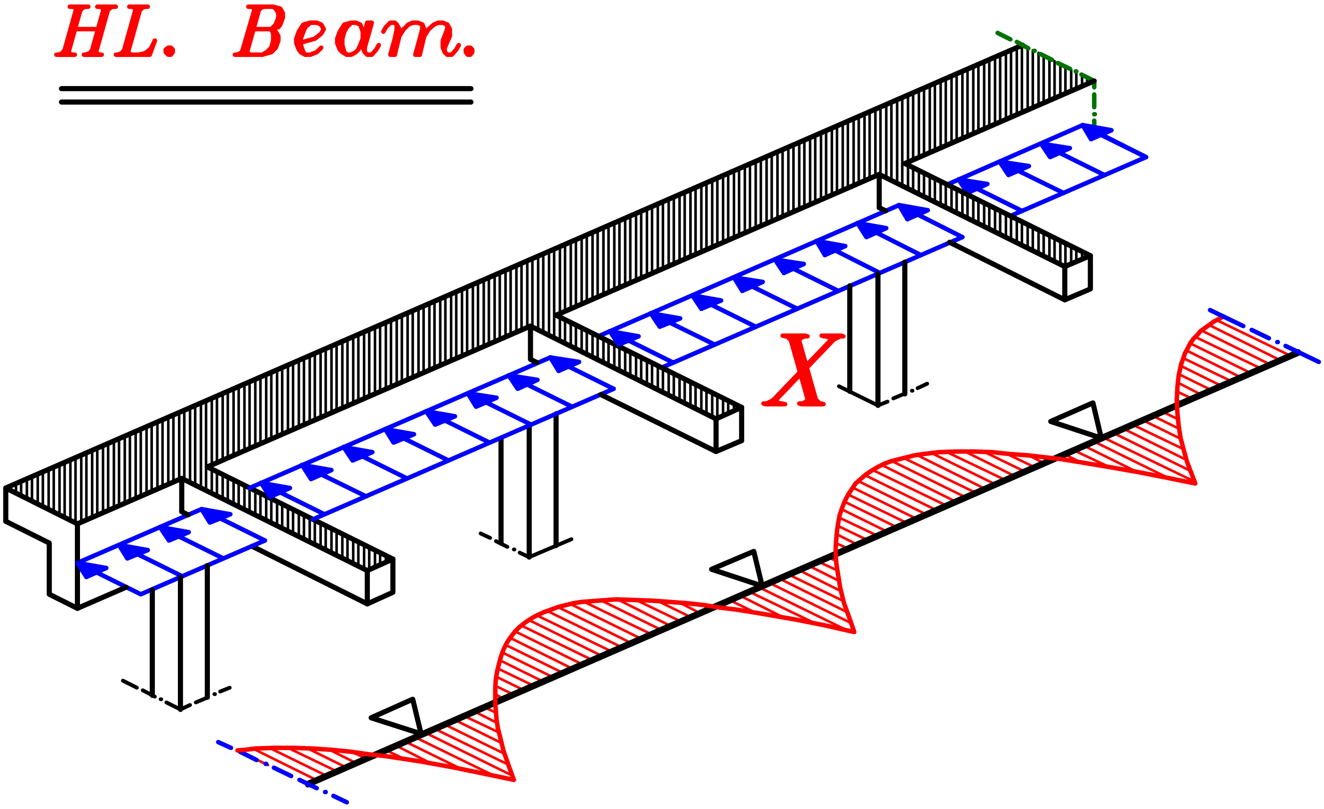


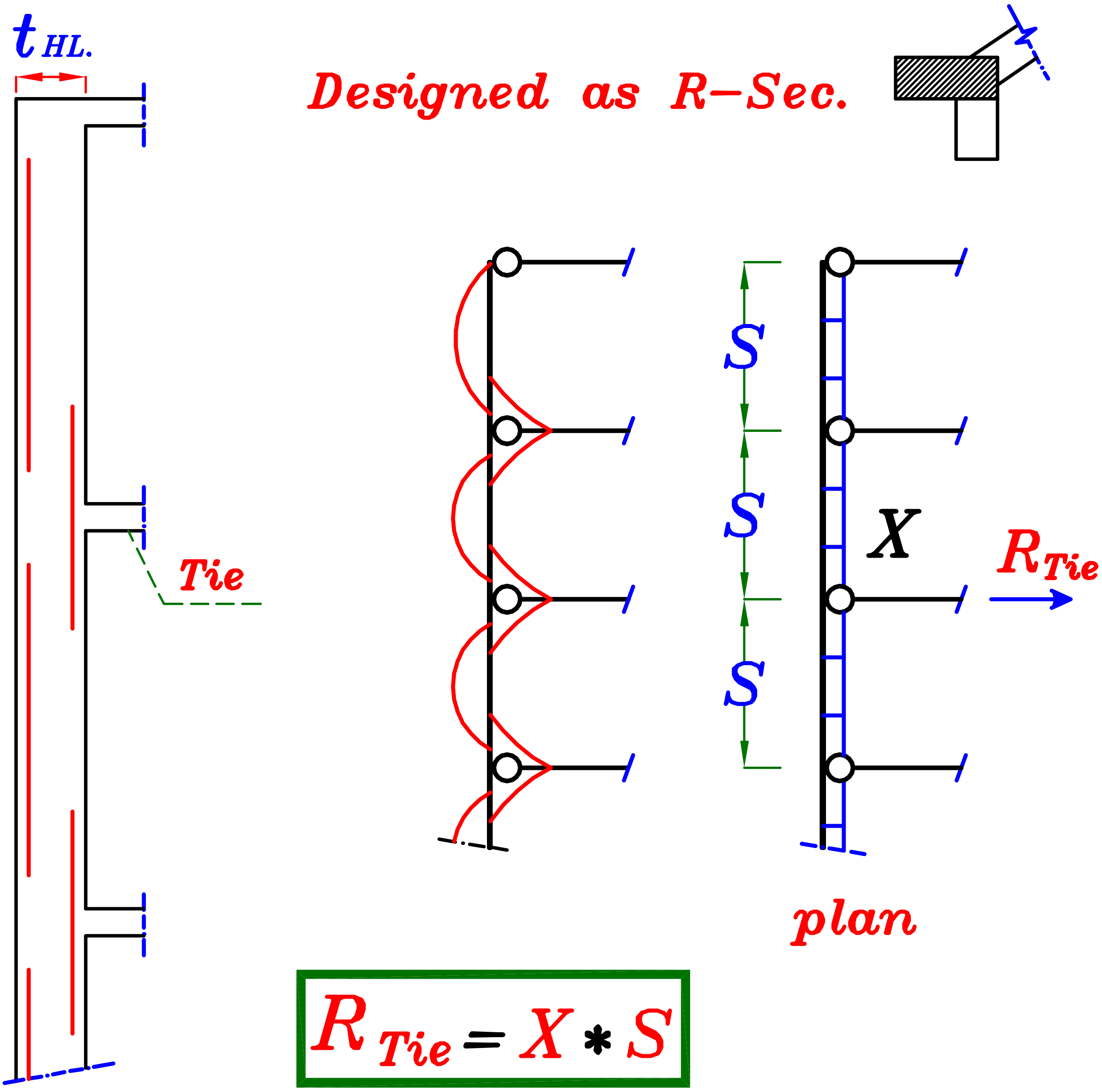






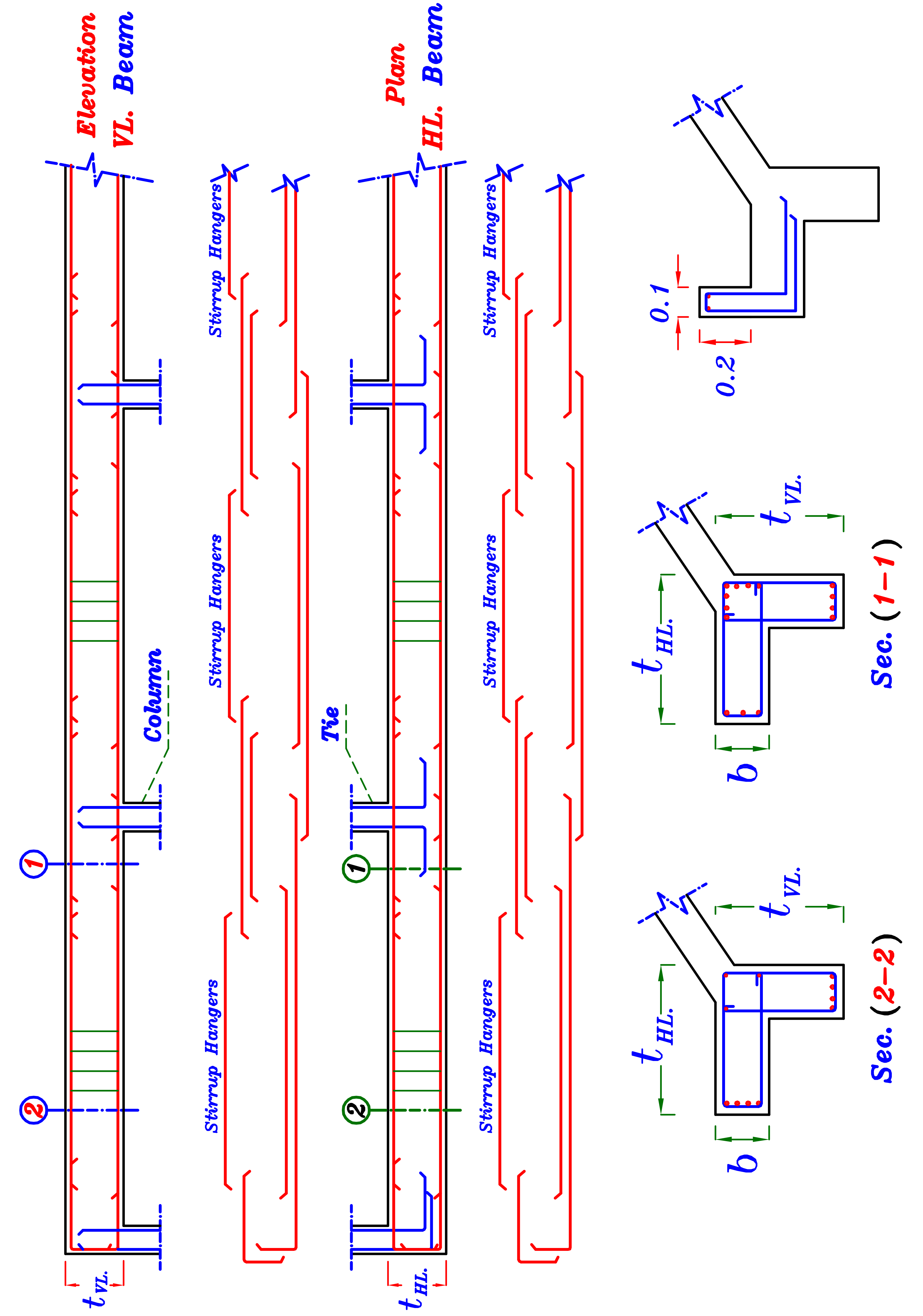
HL. Beam.



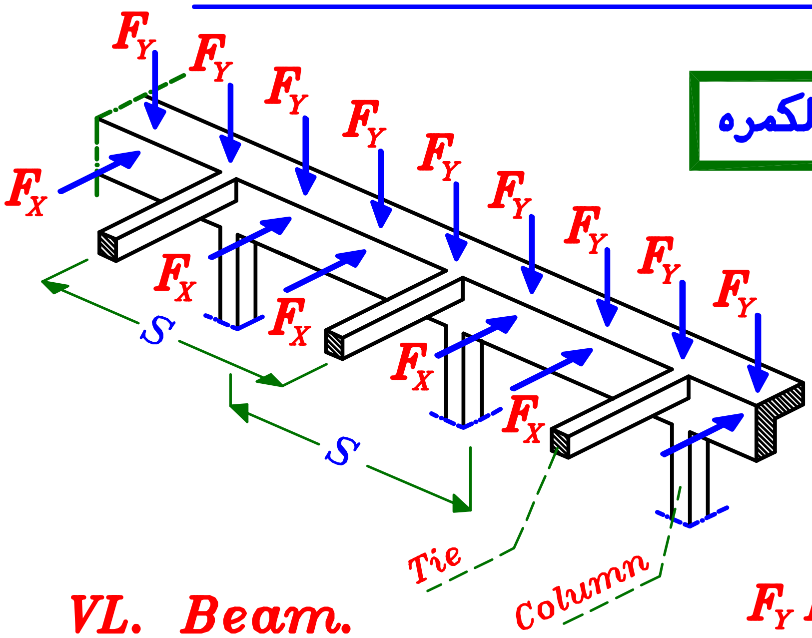


$$\boxed{R_{Tie} = X * S}$$

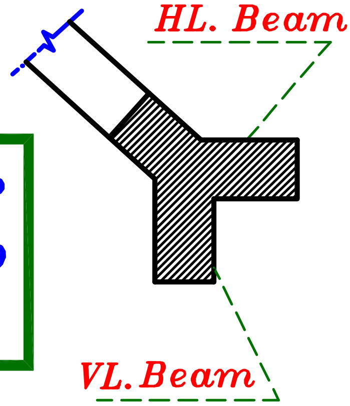
RFT. of End Beam.



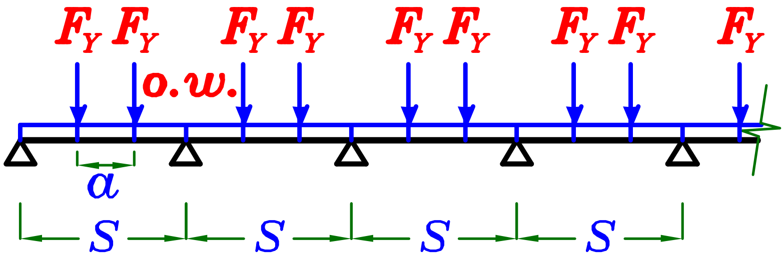
* Design of End Beam. B_2



ممكن اهمال هذه الكمره
و أخذ تسليحها
مثل B_1



VL. Beam.

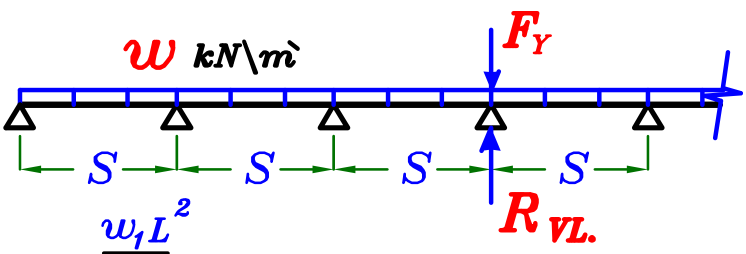


$\underset{(beam)}{O.W.}$ $(VL.+HL.) \simeq 7.0\ kN$ $(U.L.)$

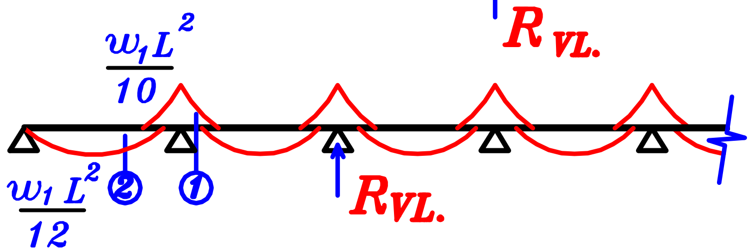
Solved by using Moment Dist. or use Approximate Solution.

$$F_Y = F \cos\beta$$

$$w = o.w. + \frac{\sum F_Y \text{ (at one span)}}{Span}$$



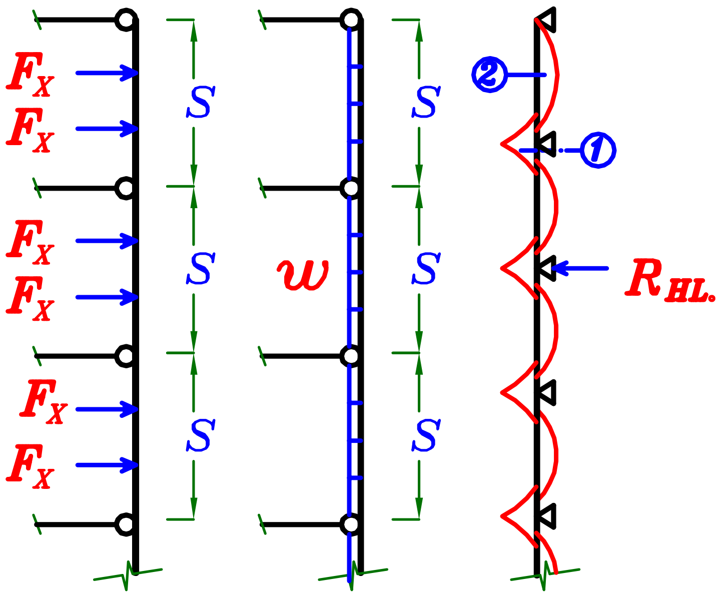
Designed as R-Sec.



HL. Beam.

$$F_X = F \sin\beta$$

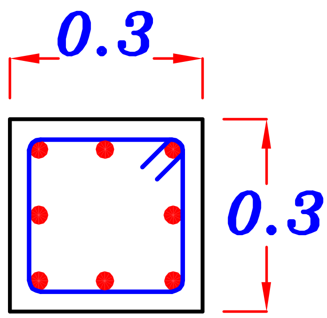
$$w = \frac{\sum F_X \text{ (at one span)}}{Span}$$



Tie.

ـ الشد الموجود فى الـ Tie ناتج من Reaction of HL. Beam

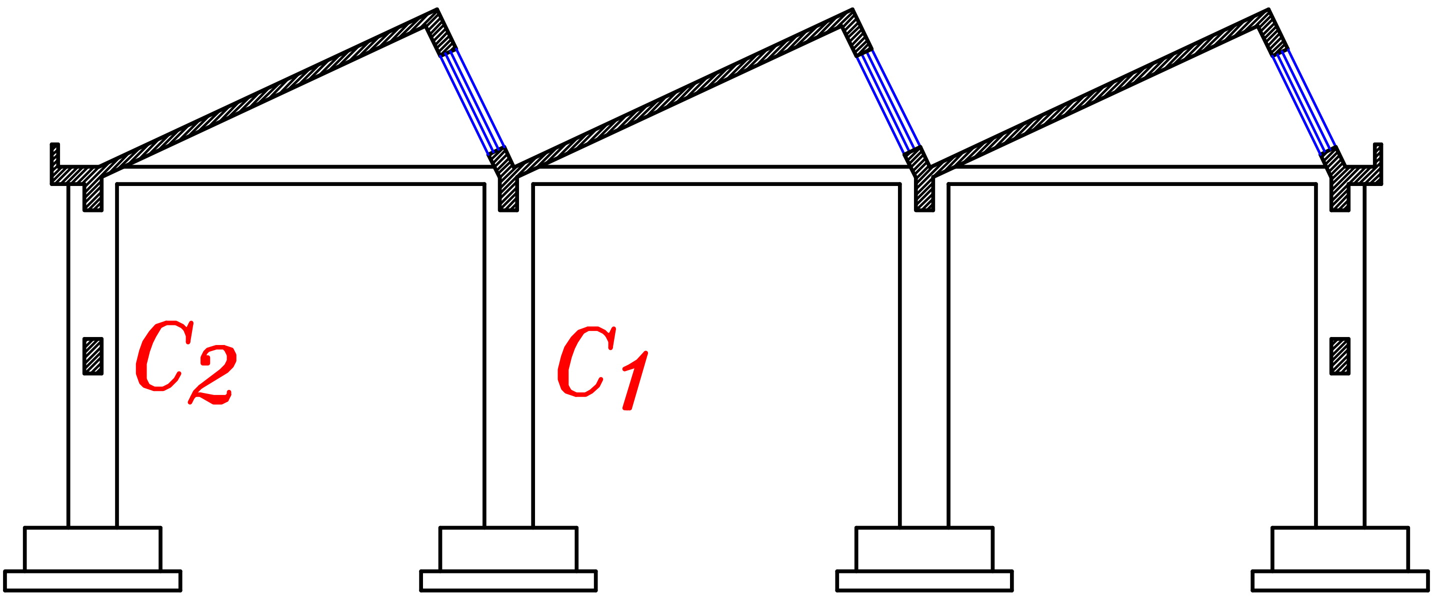
$$\boxed{T_{Tie} = X * S}$$



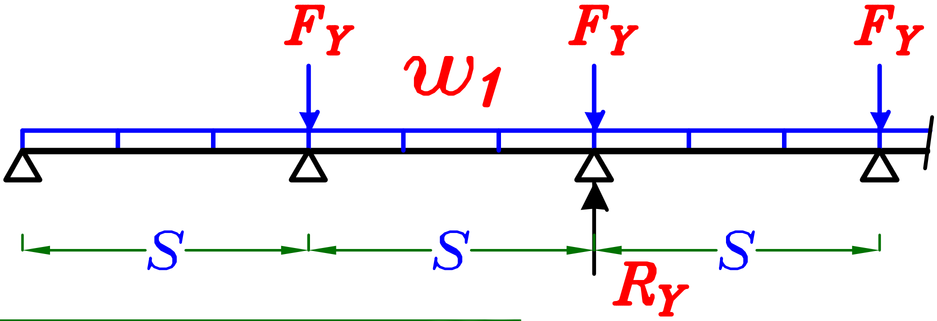
$$A_s = \frac{T_{(Tie)}}{F_y \backslash \gamma_s} = \text{(Total area of steel)}$$

$$A_c = \text{Take } (300 \times 300)$$

Columns. C_1 & C_2



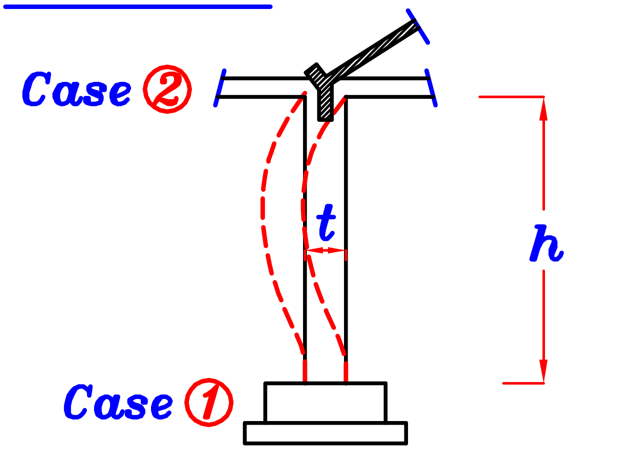
C_1 P = Reaction of Y–beam. R_Y



$$\boxed{R_Y = w_1 * S + F_Y}$$

Check Buckling.

① In plane.

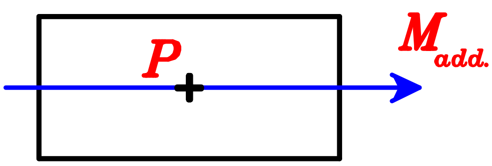


$H_\circ = h$

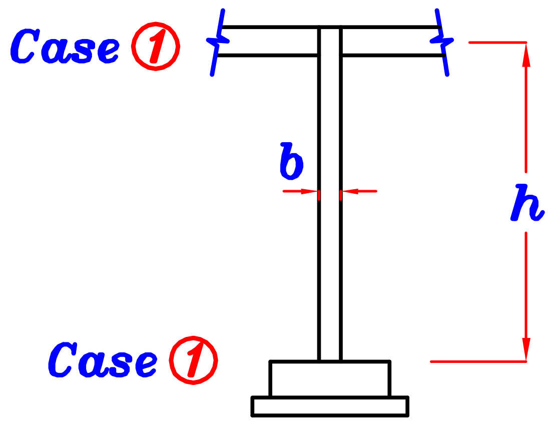
$$\lambda_b = \frac{1.3 * H_\circ}{t}$$

IF $\lambda_b \leqslant 10 \xrightarrow{\text{Designed}} P$ only

$\lambda_b > 10 \xrightarrow{\text{Designed}} P, M_{add.}$



② Out of plane.

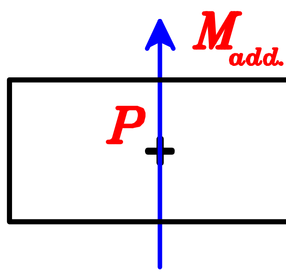


$H_\circ = h$

$$\lambda_b = \frac{1.2 * H_\circ}{b}$$

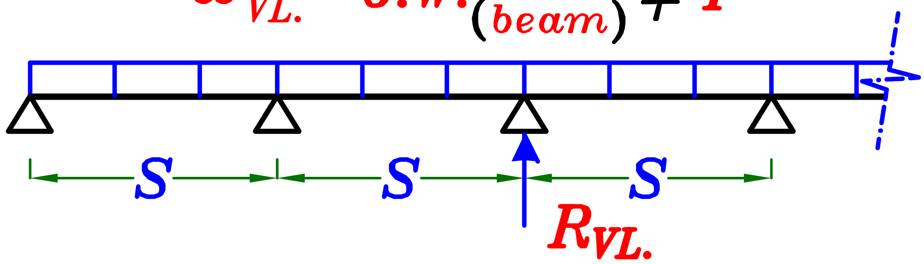
IF $\lambda_b \leqslant 10 \xrightarrow{\text{Designed}} P$ only

$\lambda_b > 10 \xrightarrow{\text{Designed}} P, M_{add.}$



C_2 P = Reaction of VL. beam $R_{VL.}$

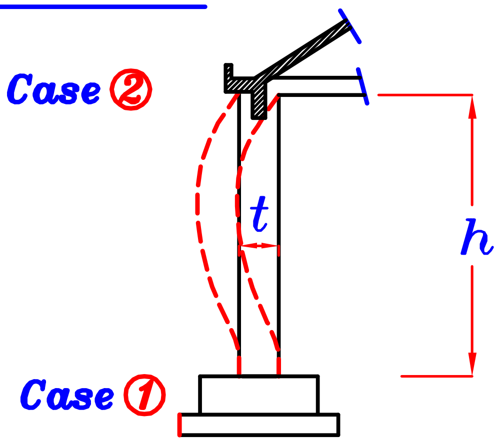
$$w_{VL.} = O.W._{(beam)} + Y$$



$$\boxed{R_{VL.} = w_{VL.} * S}$$

Check Buckling.

① In plane.

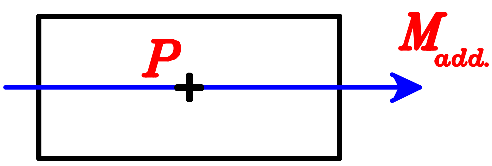


$H_o = h$

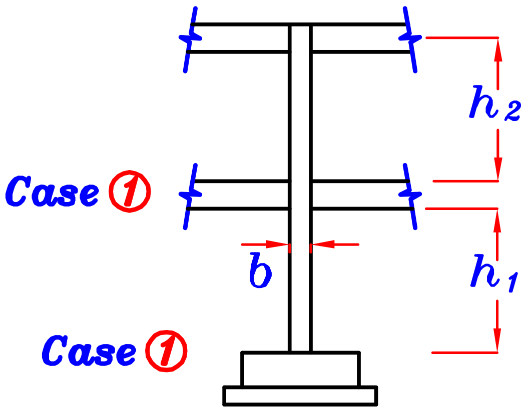
$$\lambda_b = \frac{1.3 * H_o}{t}$$

IF $\lambda_b \leqslant 10 \xrightarrow{Designed} P$ only

$\lambda_b > 10 \xrightarrow{Designed} P, M_{add.}$



② Out of plane.

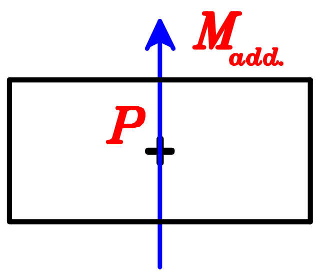


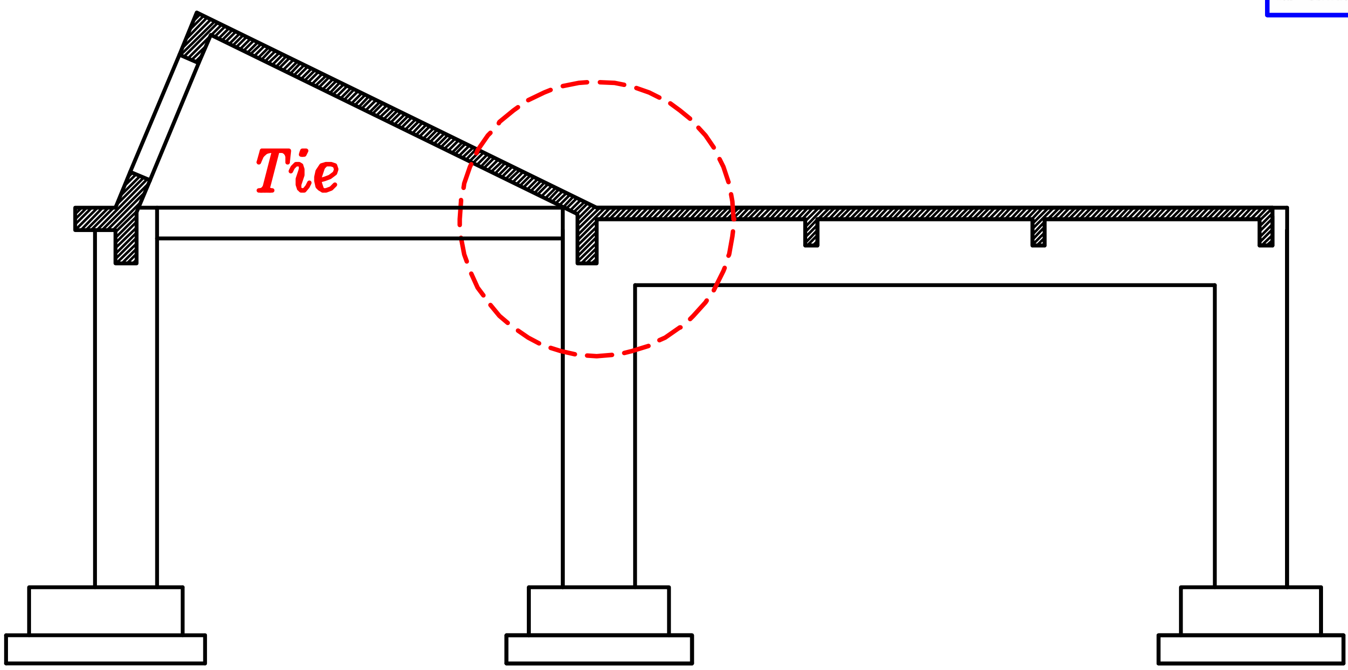
H_o = bigger of h_1 & h_2

$$\lambda_b = \frac{1.2 * H_o}{b}$$

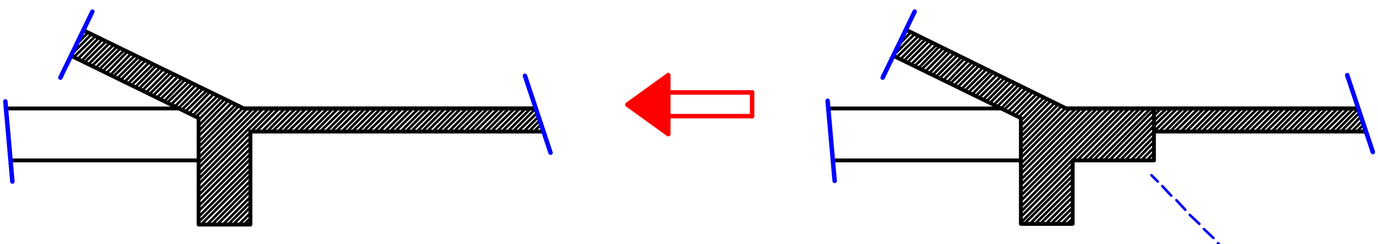
IF $\lambda_b \leqslant 10 \xrightarrow{Designed} P$ only

$\lambda_b > 10 \xrightarrow{Designed} P, M_{add.}$





عند وجود بلاطه أفقيه عند *End Beam* لا يتم وضع كمره أفقيه



لن نحتاج لهذه الكمره الافقيه

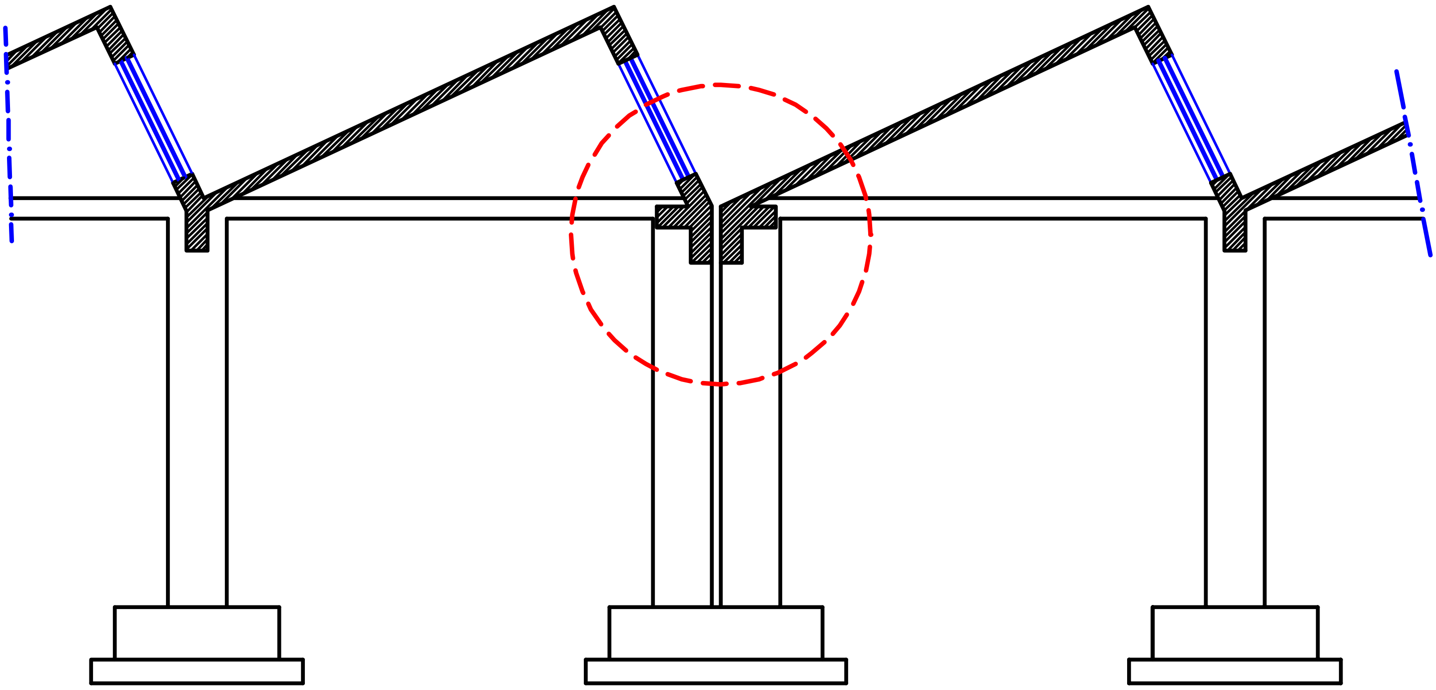
البلاطه الافقيه تعمل عمل
الكمره الافقيه و تحمل القوى
الافقيه ثم تنقلها للـ *Tie*

المفروض تصميم البلاطه لتتحمل *moment & Compression*

فيتم تصميم البلاطه على *M,P* باستخدام *Interaction Diagram*

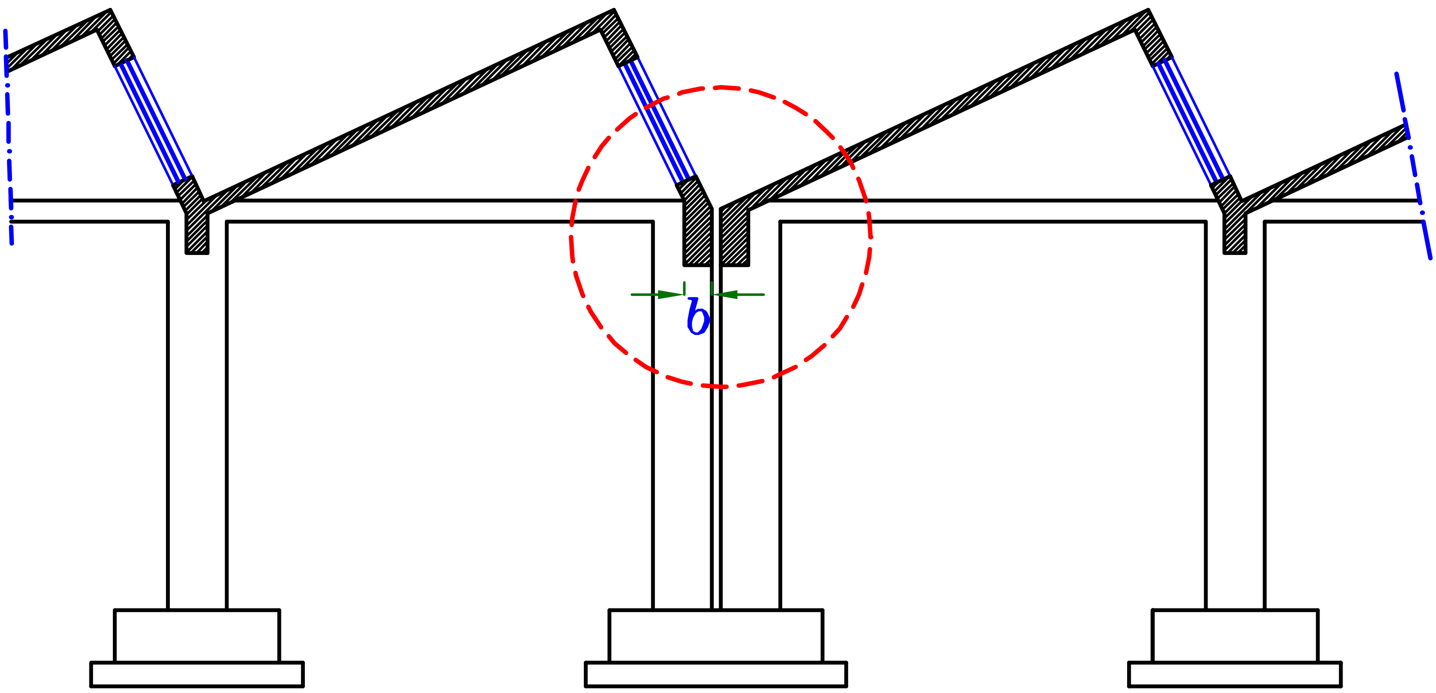
Expansion Joint with Saw tooth Slab type.

عند وجود **Expansion joint** مع وجود **HL. Beam** يجب تحويل اتجاهها للداخل

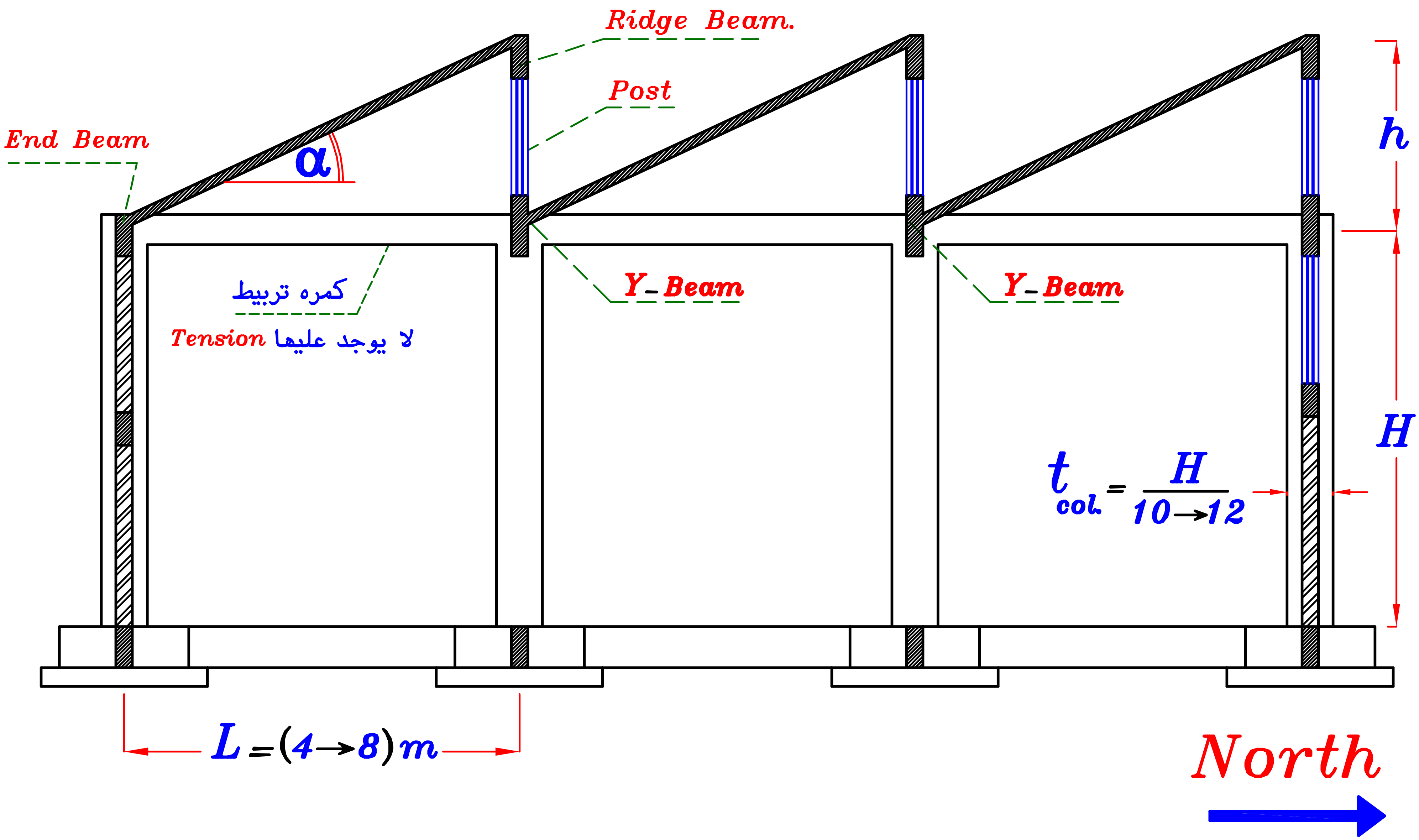


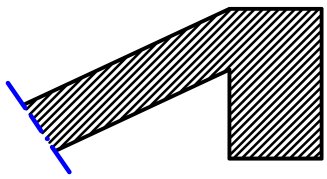
أو ممكن وضع كمره رأسيه فقط لكن تصمم لتتحمل أحمال رأسيه و أفقيه معا

و عاده نجعل **b=400 mm** و تصمم الكمره **Bi-Axial moment**



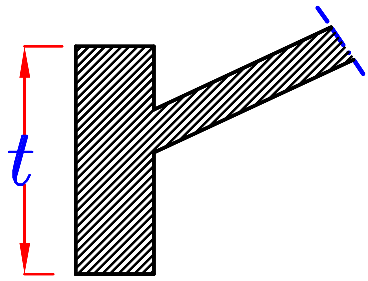
Saw Tooth Slab Type with Vertical Posts. $\beta = 0.0$





Ridge beam

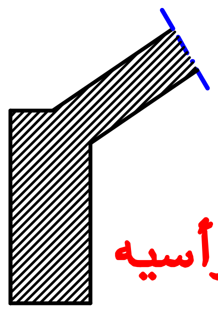
- عندما يكون الـ post رأسى ستكون الـ Ridge beam رأسيه حتى تكون الاحمال فى نفس اتجاه الـ post
axial loads on post



Y-Beam

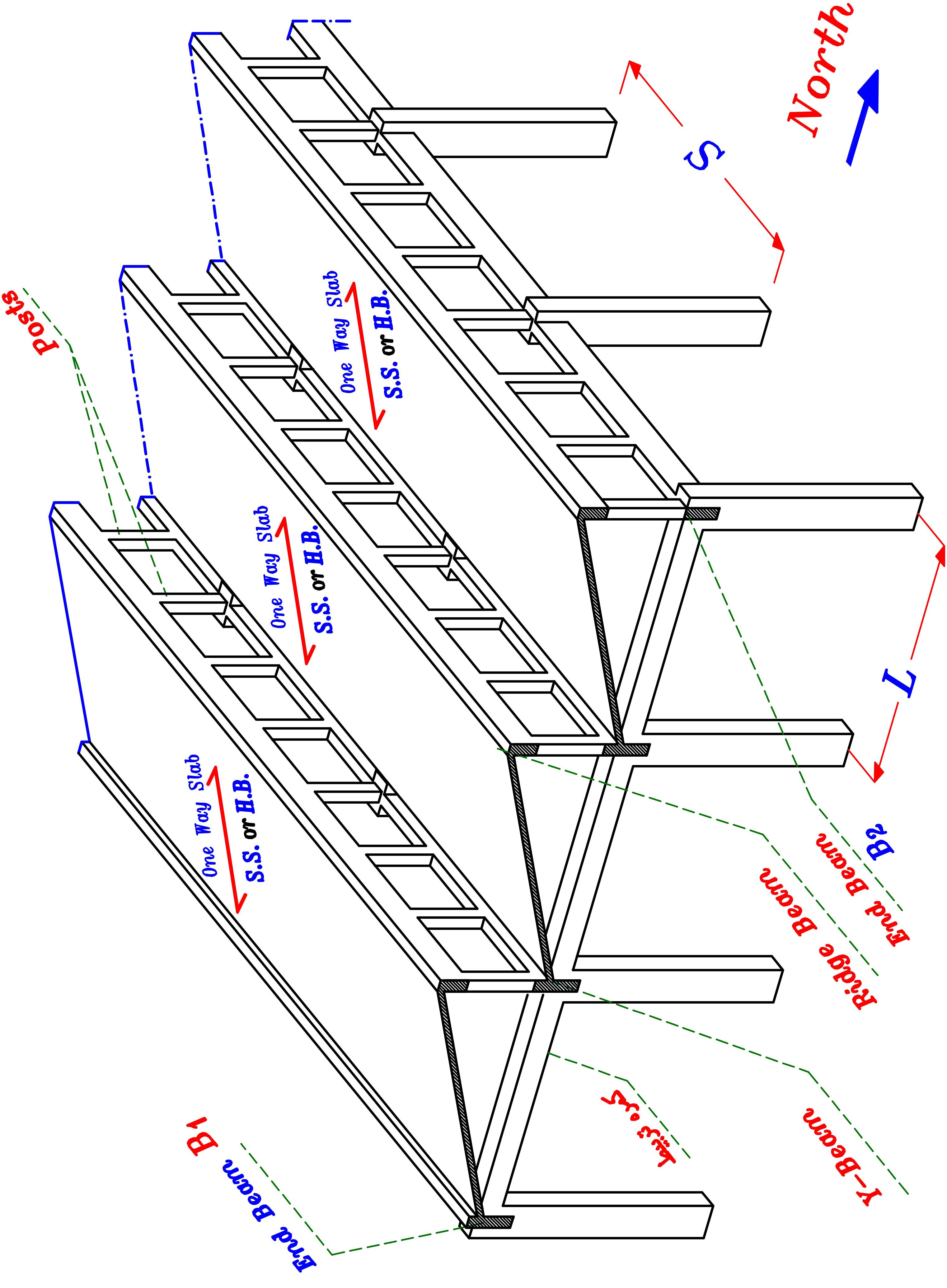
- لان الـ post رأسى فتكون الـ Y-Beam رأسيه .

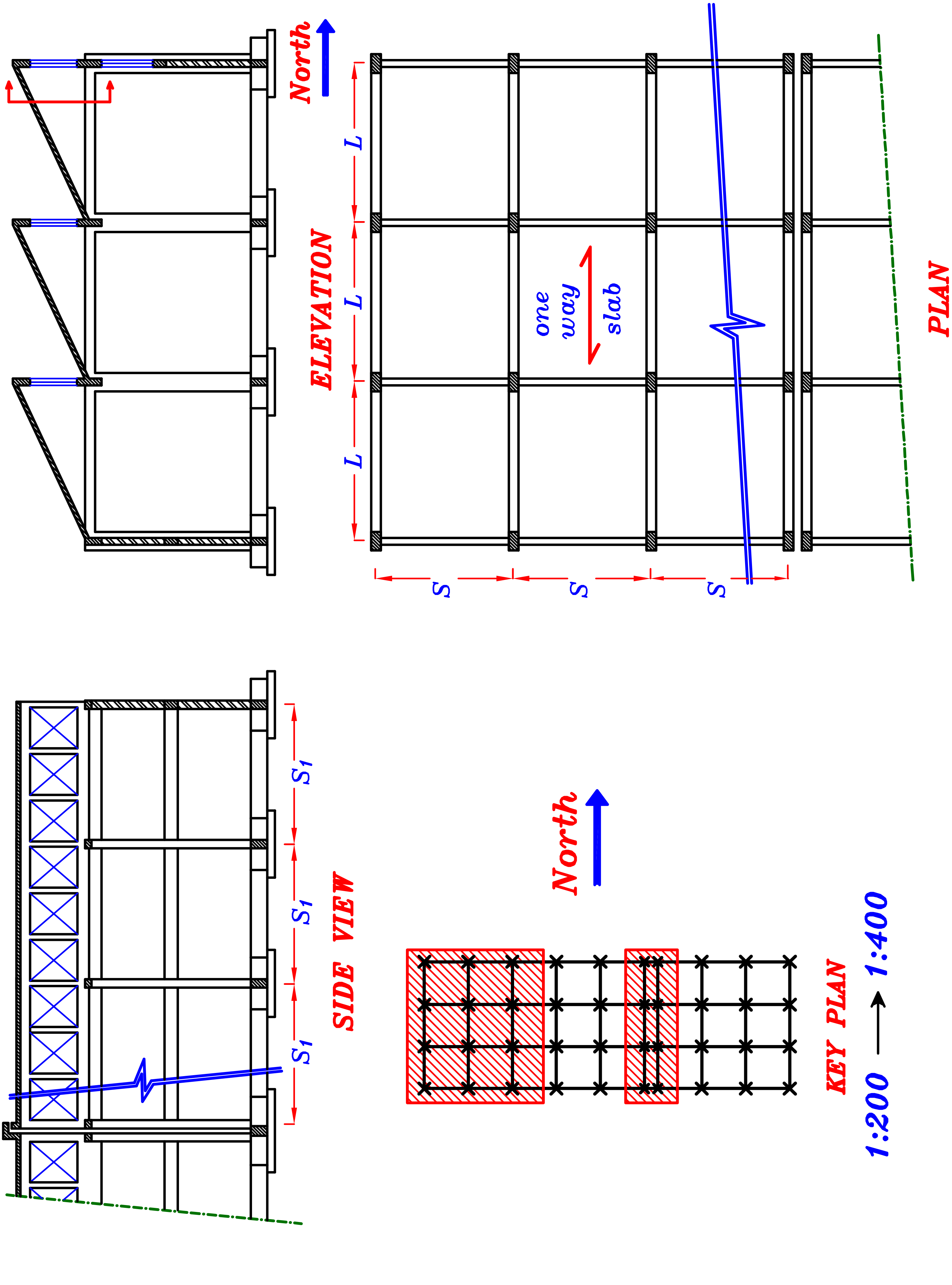
- لان الـ Ridge beam رأسيه فلن توجد مركبه أفقيه .



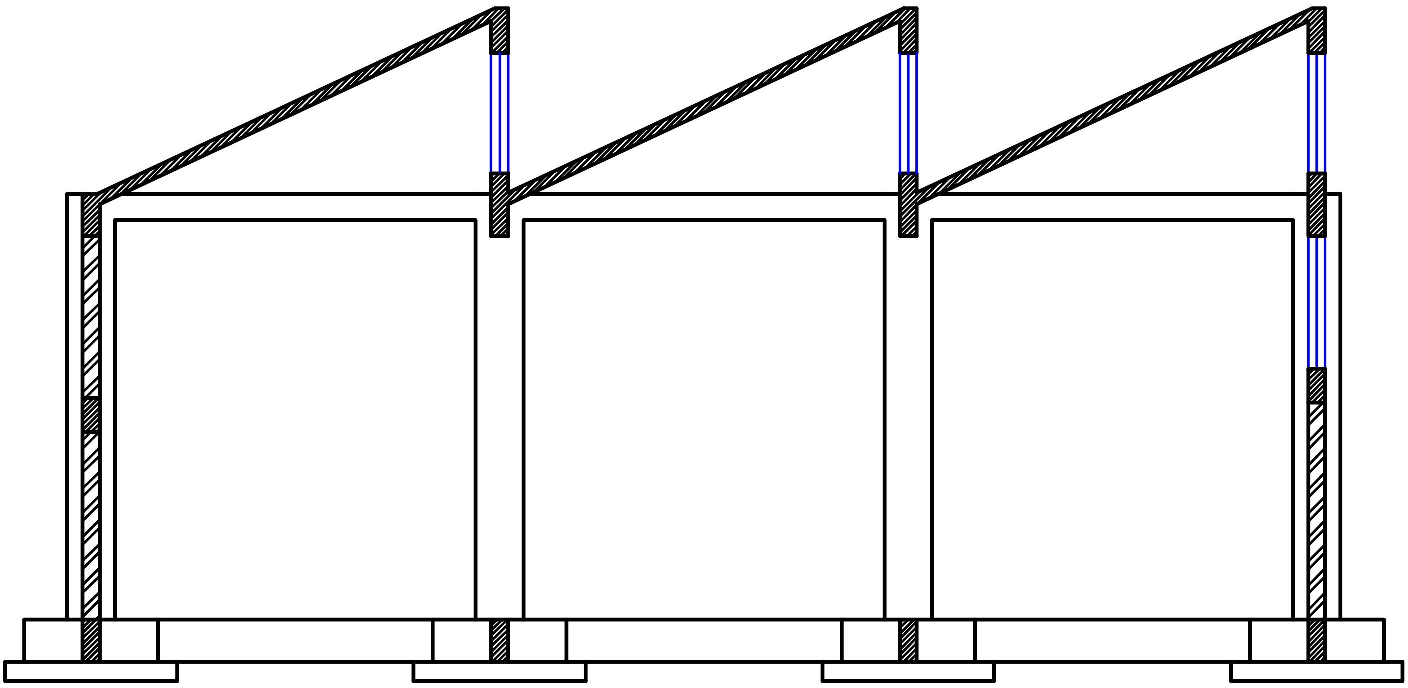
End beam

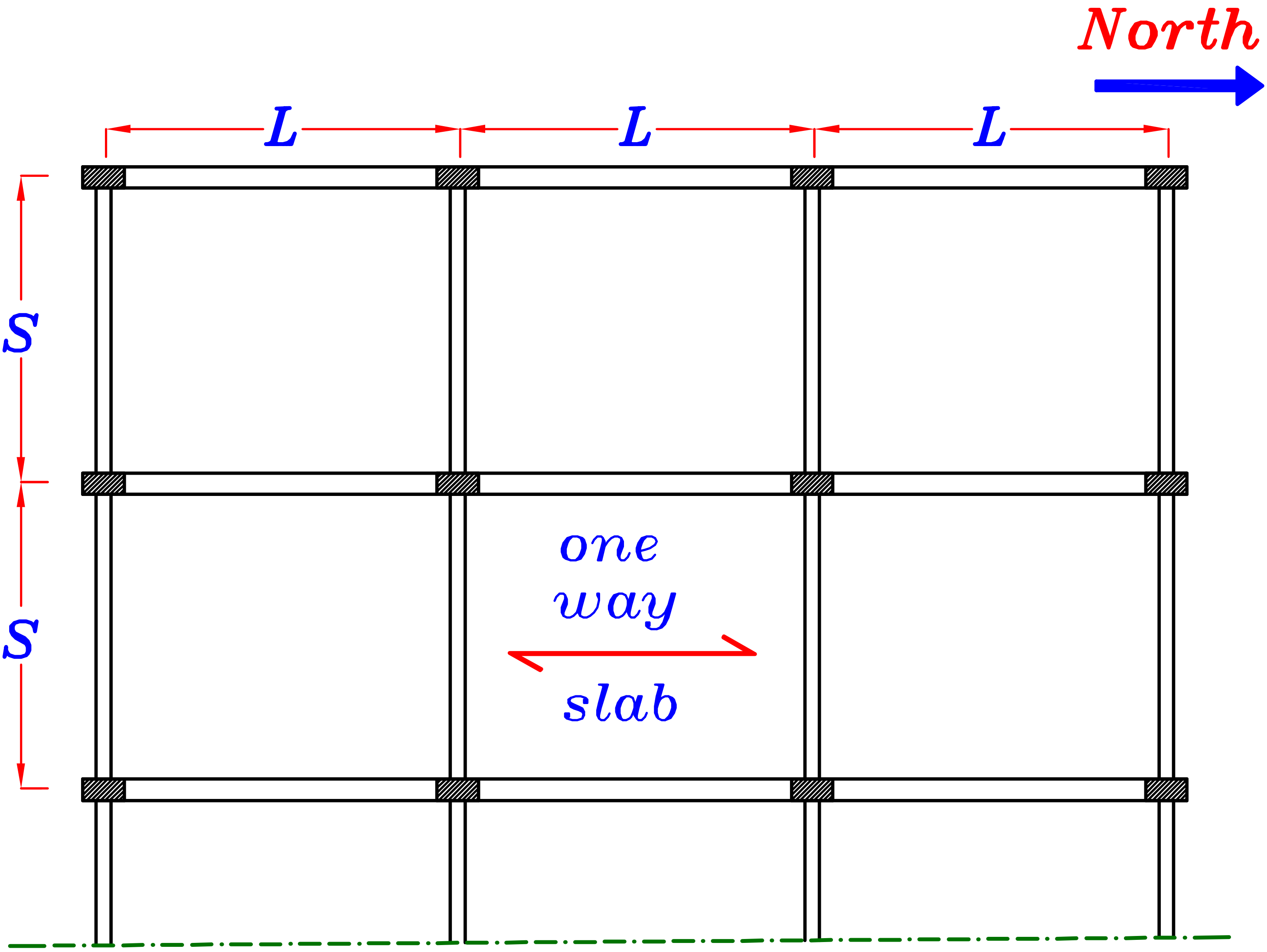
- لانه لا توجد مركبه أفقيه فلن نحتاج لـ HL. Beam فتتكون الـ End Beam من كمره رأسيه فقط.


North
S
L
posts
One Way Slab
S.S. or H.B.
One Way Slab
S.S. or H.B.
One Way Slab
S.S. or H.B.
End Beam B2
Ridge Beam
Y-Beam
End Beam B1

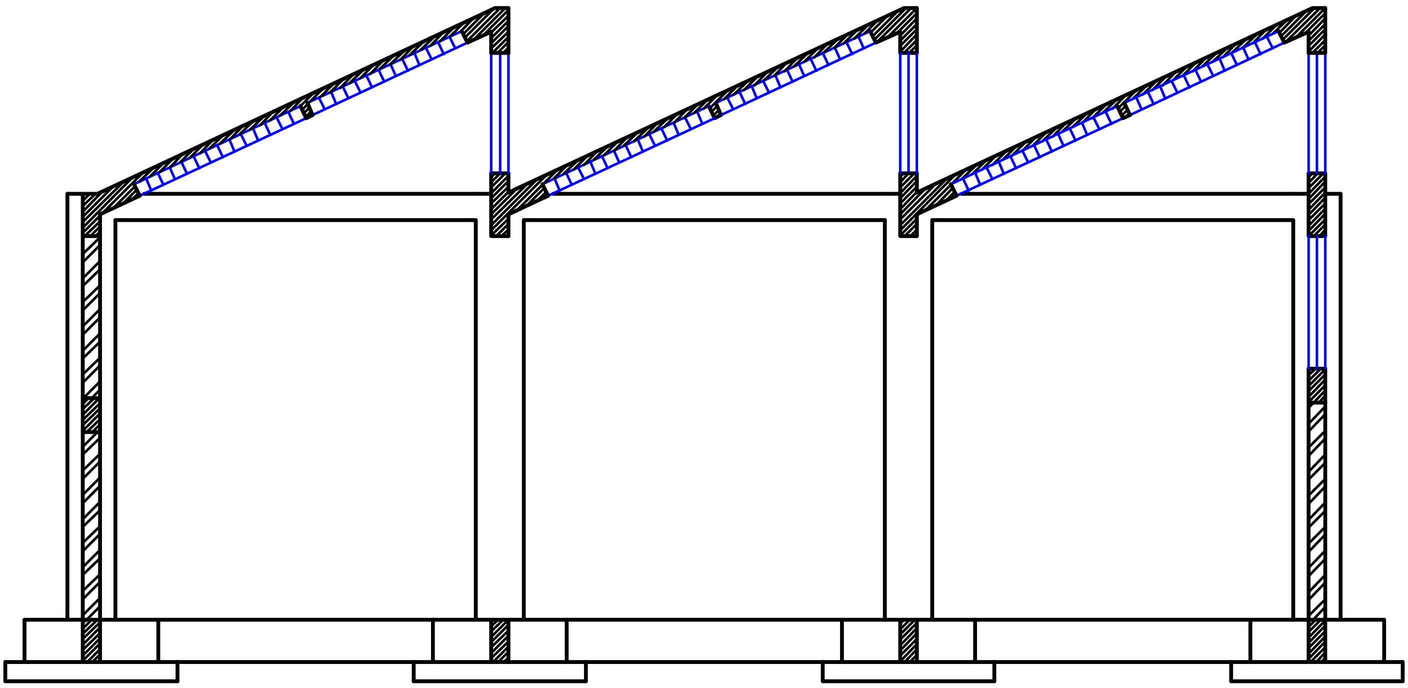

North
ELEVATION
L
L
L
one way slab
PLAN
S
S
S
SIDE VIEW
S_1
S_1
S_1
North
KEY PLAN
1:200 → 1:400

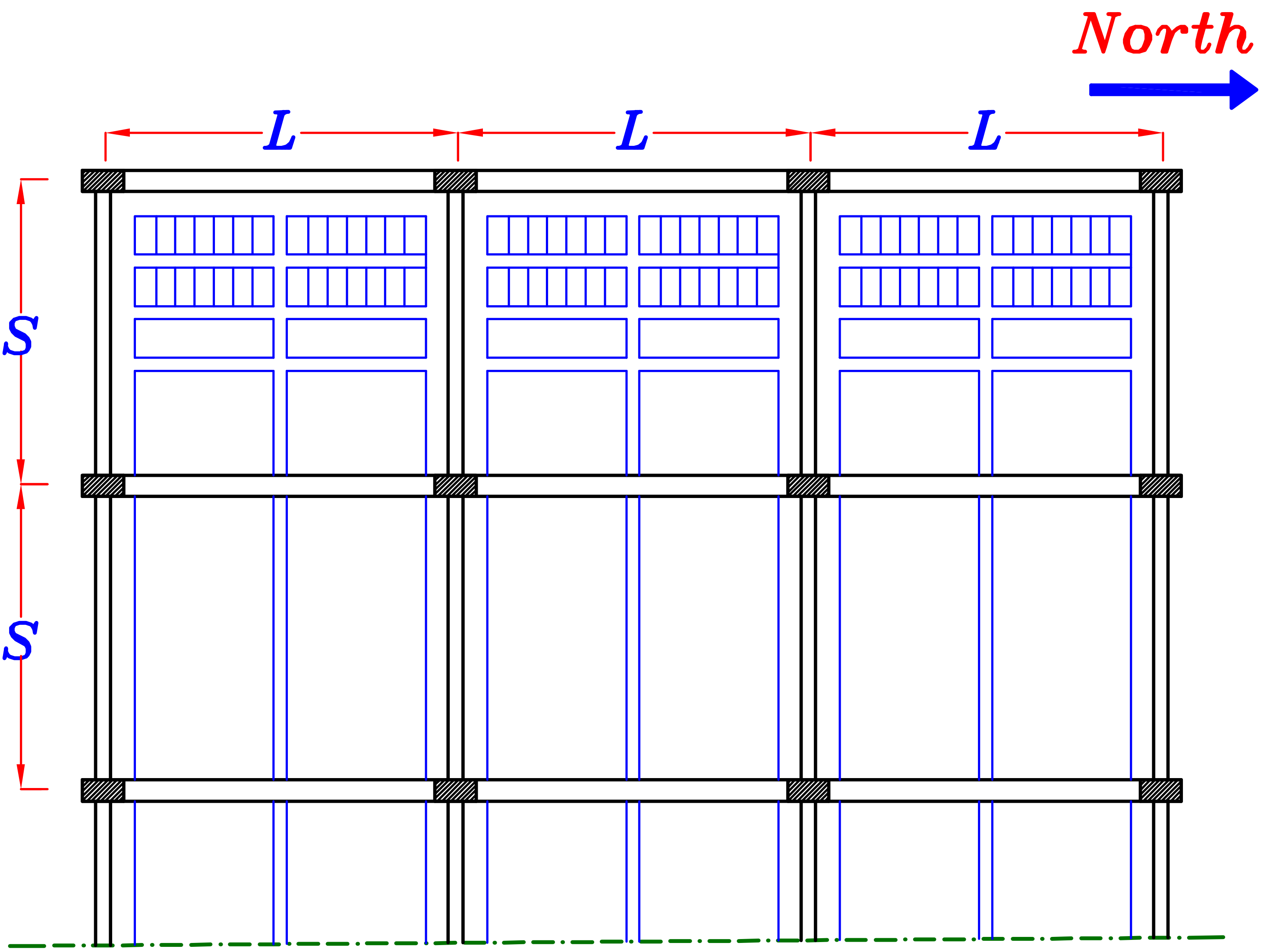
Saw Tooth Slab Type Solid Slab $L \leqslant 6.0\,m$



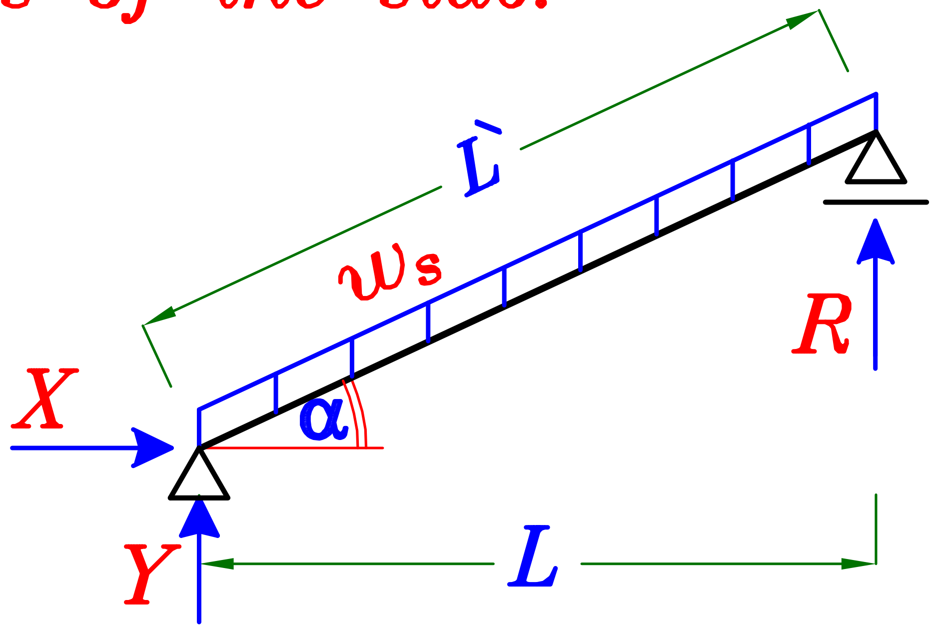


Saw Tooth Slab Type H.B. Slab $L > 6.0\,m$





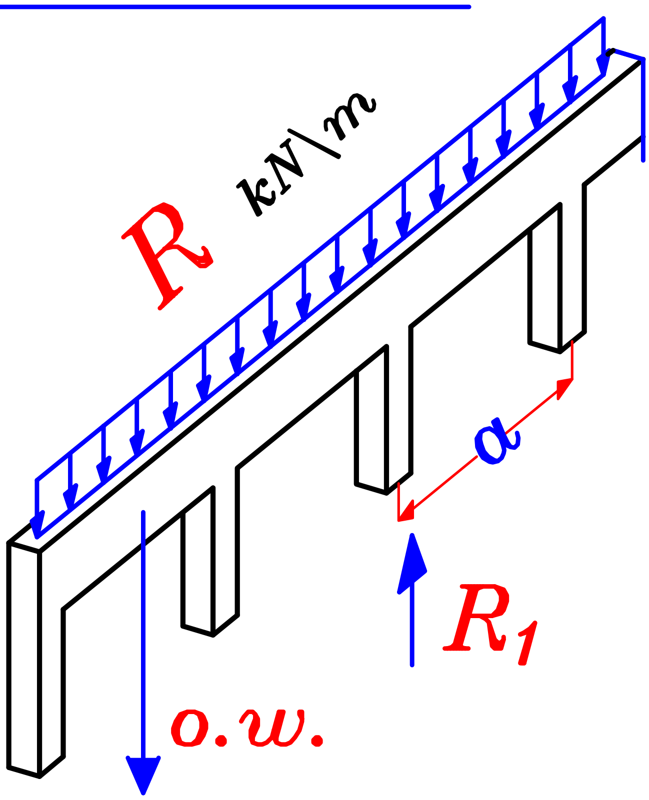
Reactions of the slab.



$$R = Y = \frac{w_s \, L`}{2}$$

Ridge Beam.

لا يوجد تحليل للوزن



$$w = o.w + R$$

$$R_1 = w * a$$

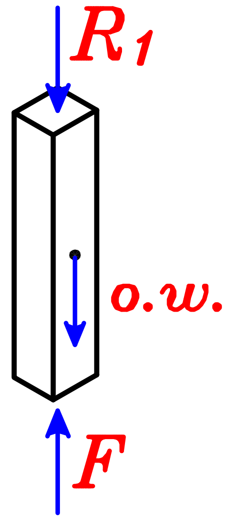
Post.

- ينتقل الحمل من ال **Ridge beam** الى ال **post**

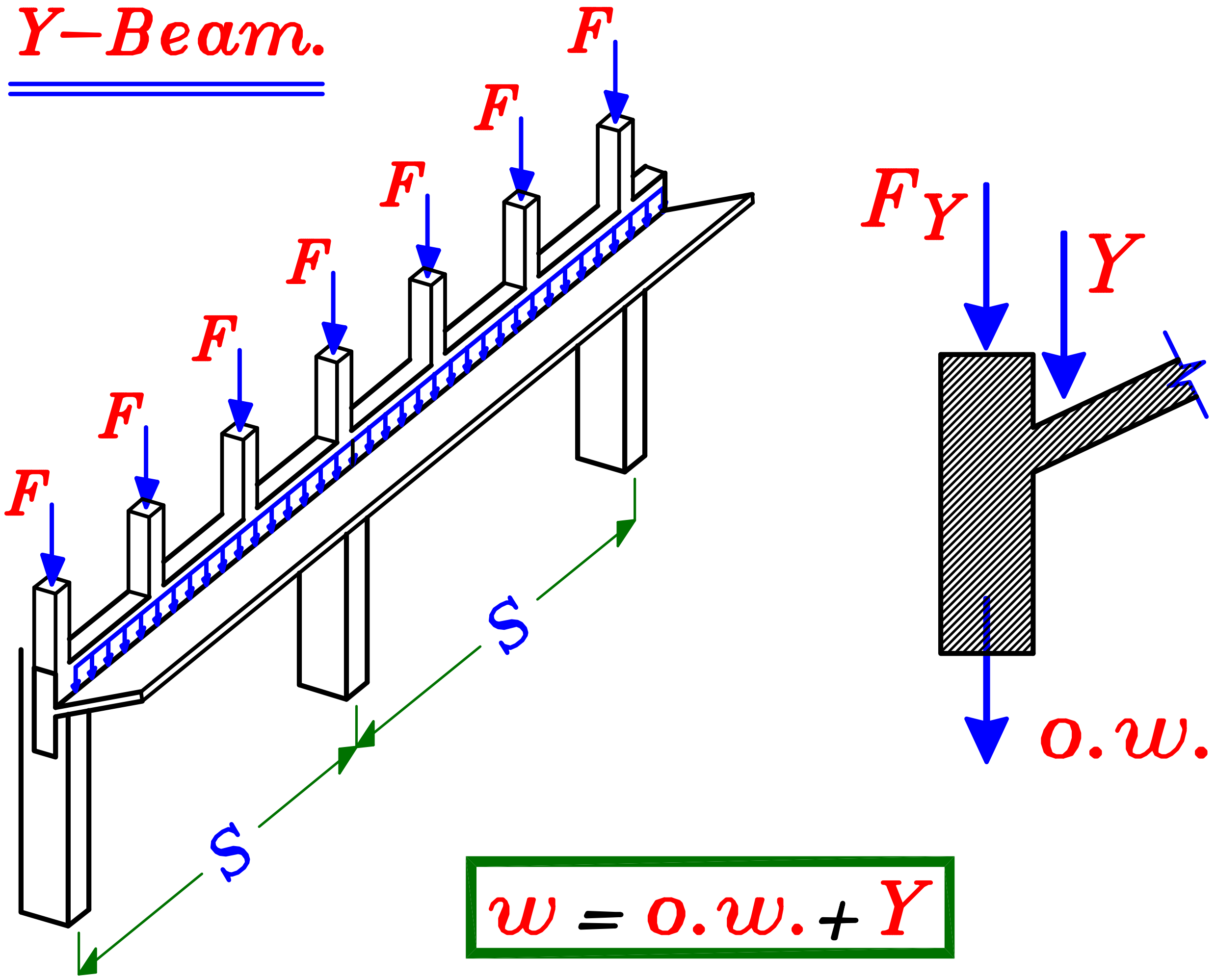
لا يوجد تحليل للوزن

$$F = O.W._{(Post)} + R_1$$

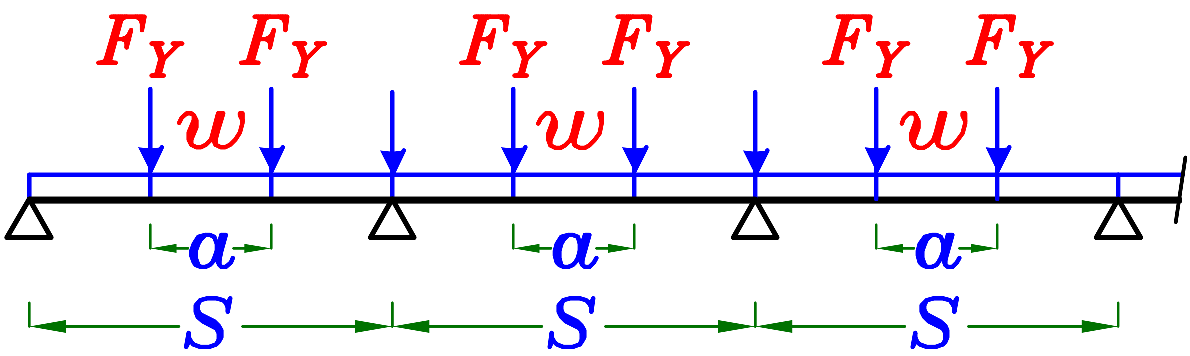
$$O.W._{(Post)} \simeq 3.50\ kN\ (U.L.)$$



Y–Beam.

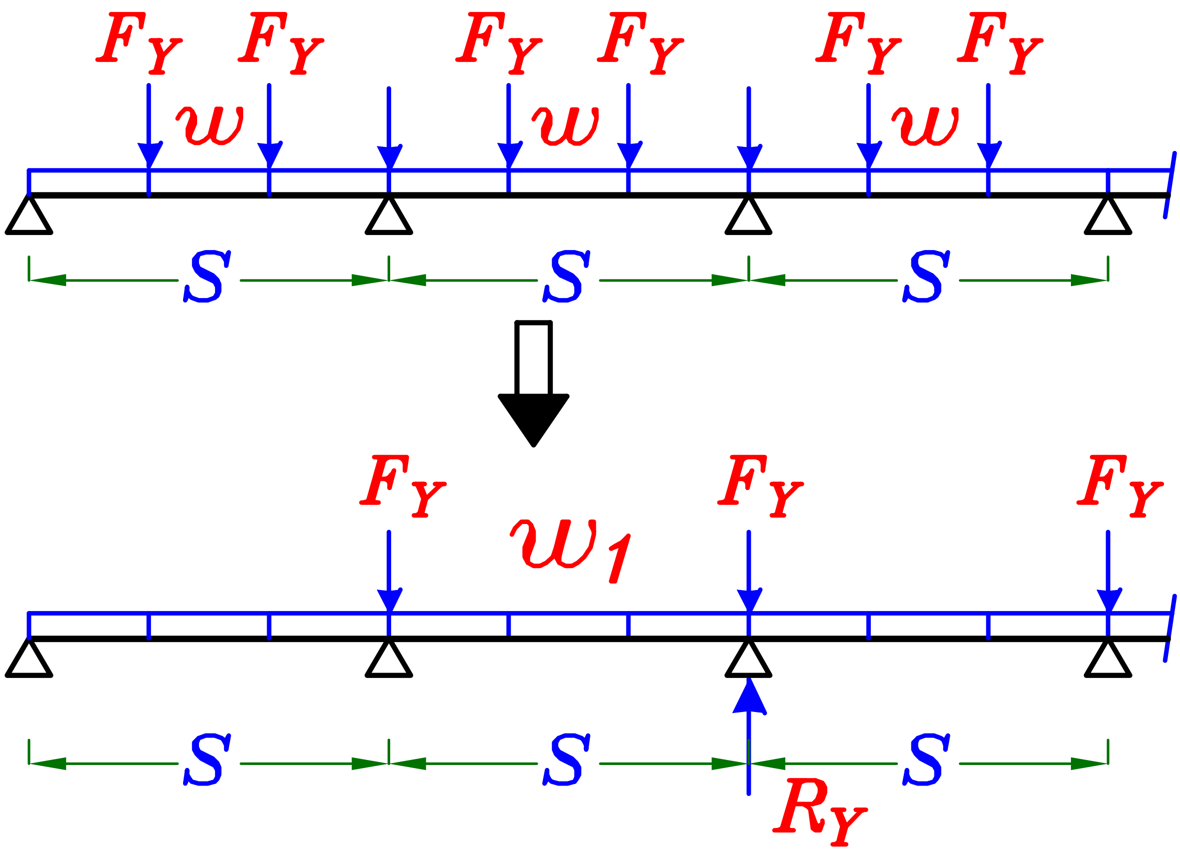


$$\boxed{w = o.w. + Y}$$



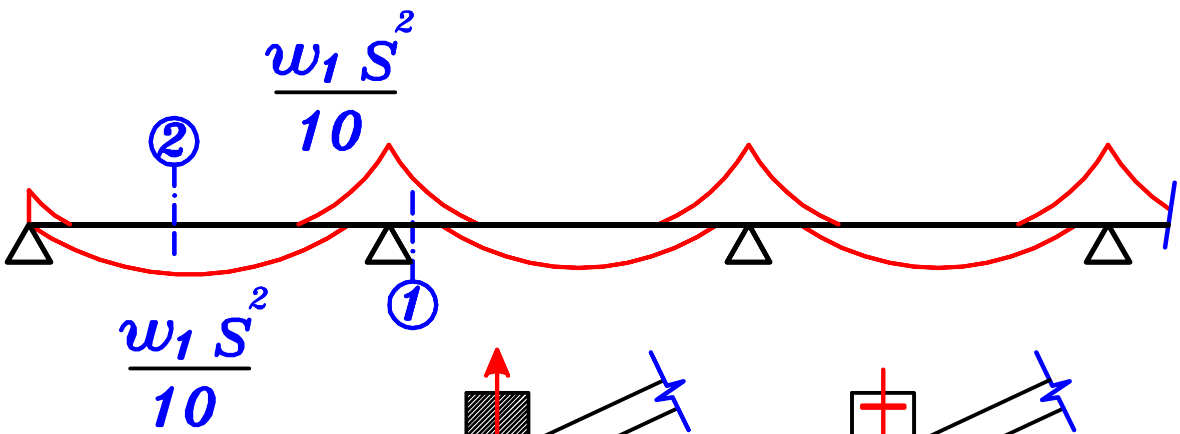
لحل الكمره ال Y-beam

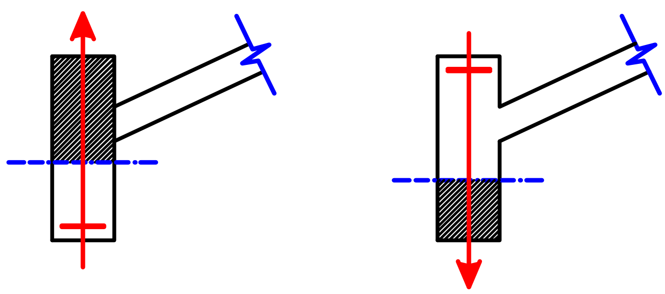
نعمل على تحويل الاحمال المركزه الى أحمال منتظمه .

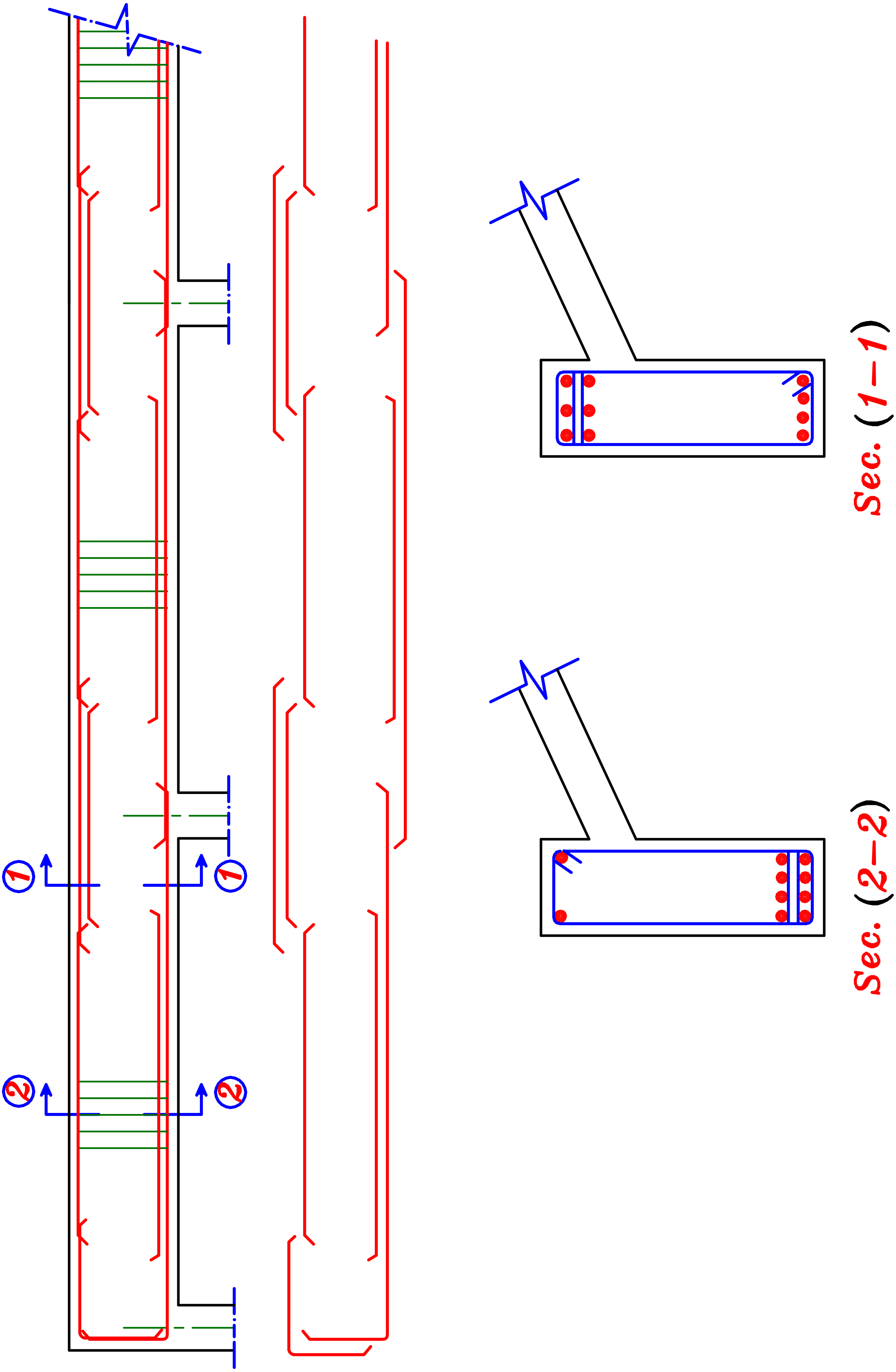


$$w_1 = w + \frac{\Sigma F_Y}{S}$$

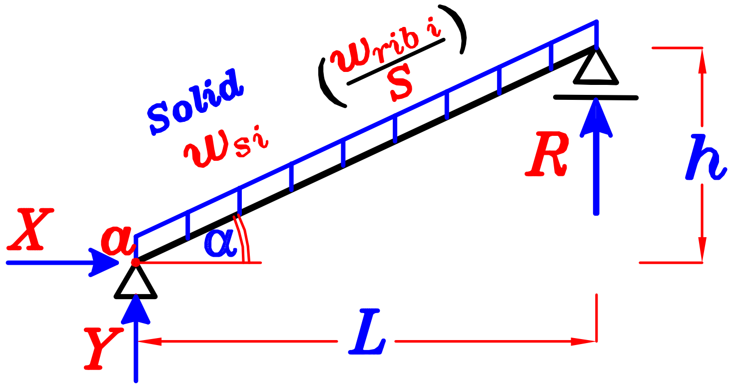
$$R_Y = w_1 * S + F_Y$$






1
2
Sec. (1–1)
Sec. (2–2)

خطوات تصميم $Y-Beam$ الشباك رأسى



نأخذ شريحه فى البلاطه عرضها - ١,٠ م

و نحدد ال R ، Y Reactions

$$\boxed{w = R + o.w}$$

$$\boxed{R_1 = w * a}$$

Ridge Beam

$$\boxed{F = R_1 + o.w}$$

$$\boxed{F_Y = F}$$

Post

$$\boxed{w_1 = o.w + Y + \frac{\Sigma F_Y}{S}}$$

$$\boxed{R_Y = w_1 * S + F_Y}$$

Y-Beam

---

o.w. (Ridge Beam) = 4.2 kN/m U.L.

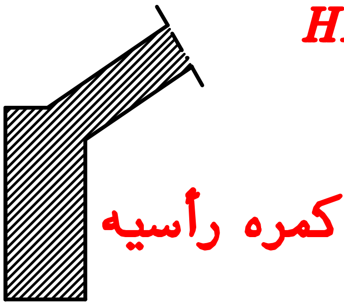
o.w. (Post) = 3.5 kN U.L.

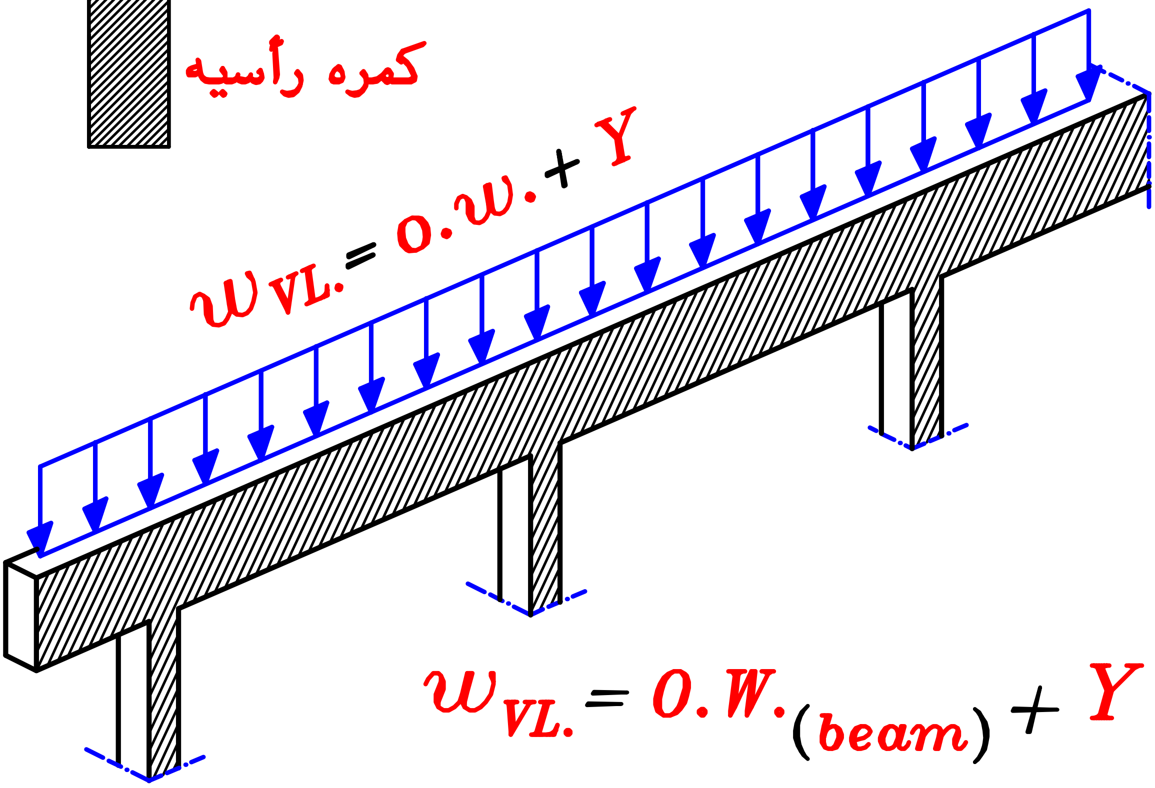
o.w. (Y-Beam) = $b\,t\,\gamma_c * 1.4$ kN/m U.L.

$$\boxed{t_{Y-beam} \simeq \frac{Spacing}{12} + 150\ mm}$$

End Beam. B_1

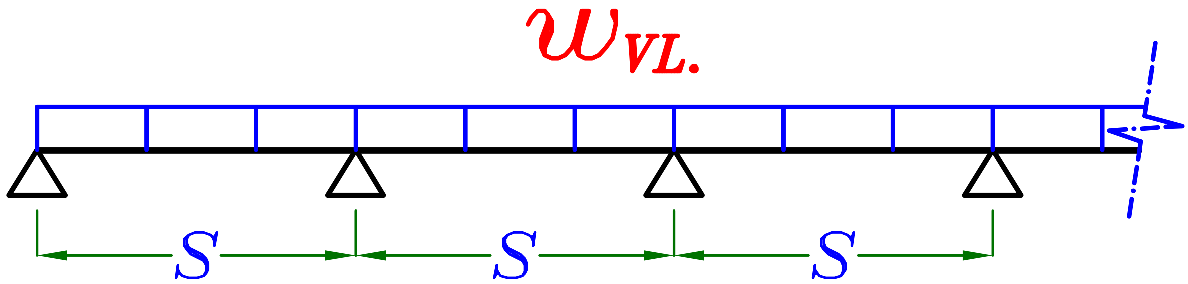
- لانه لا توجد مركبه أفقيه فلن نحتاج لـ **HL. Beam**
فتتكون الـ **End Beam** من كمره رأسيه فقط.

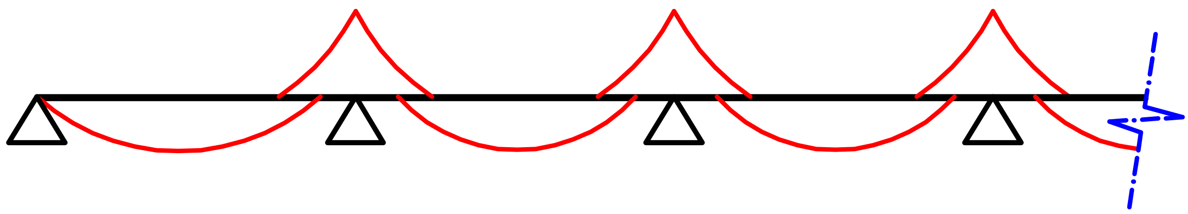


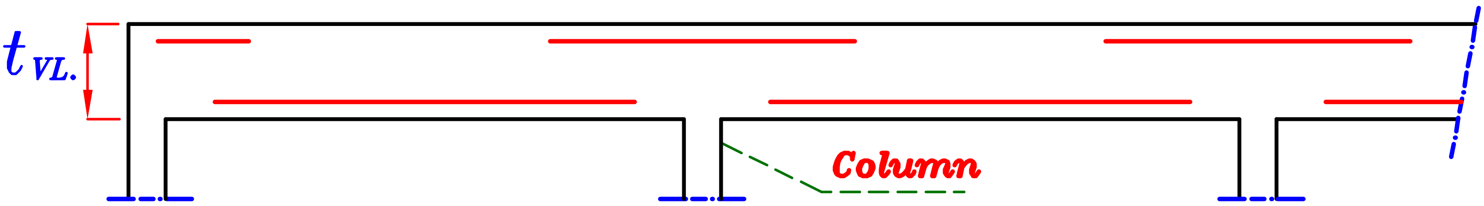


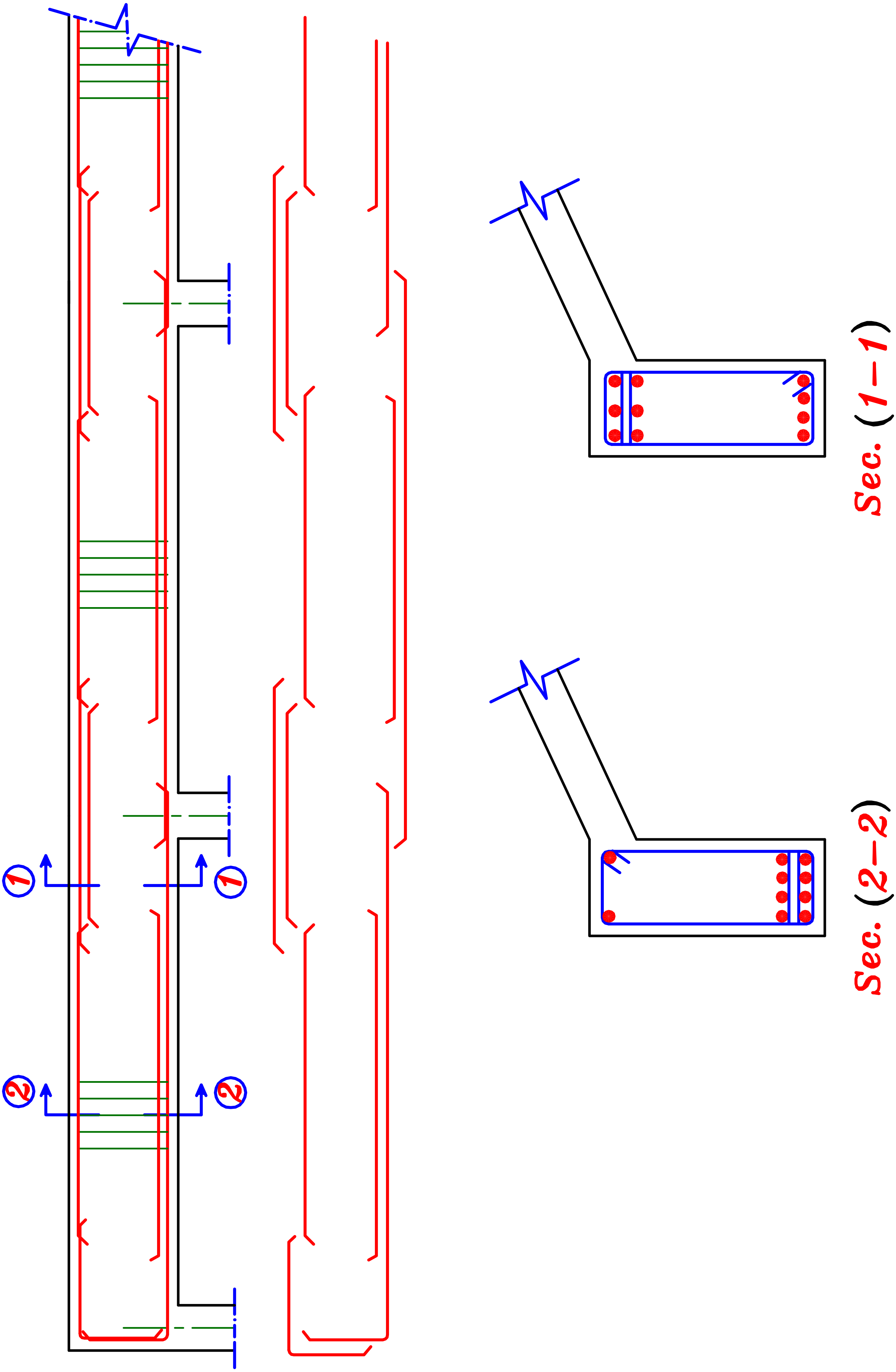
$$w_{VL.} = O.W._{(beam)} + Y \quad kN\backslash m`$$

$$\boxed{O.W._{(VL.\ beam)} = 3.0 * 1.4 = 4.2 \quad kN/m}$$








Sec. (1–1)
Sec. (2–2)
1
2

Note.

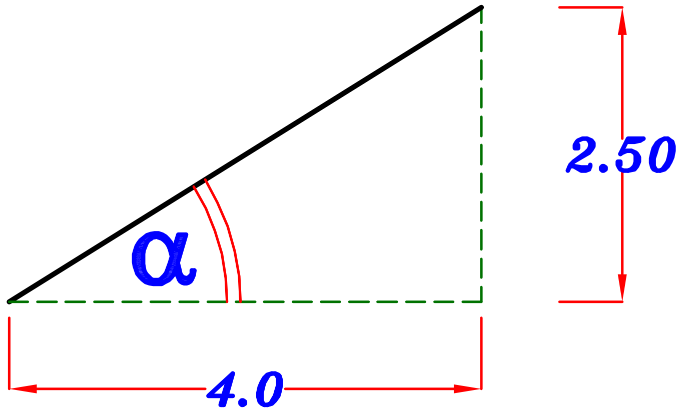
من الممكن أن يكون طول السِنّه و ارتفاعها معطى .

فاذا زادت زاويه ميل البلاطه أكبر من ٣٠° $(\alpha > 30^\circ)$

نضع بلاطه *cantilever slab* حتى لا تزيد زاويه ميل الاضاءه عن ٣٠°

Example.

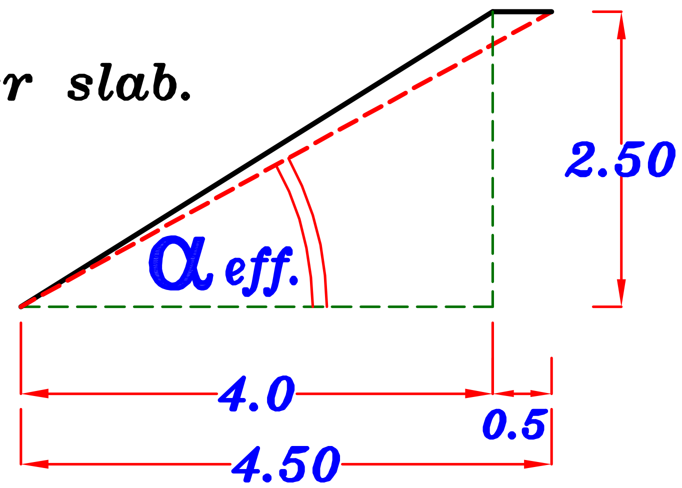
IF the saw tooth given.



Calculate

$$\tan \alpha = \left(\frac{2.5}{4.0}\right) \longrightarrow \alpha = 32.0^\circ > 30^\circ$$

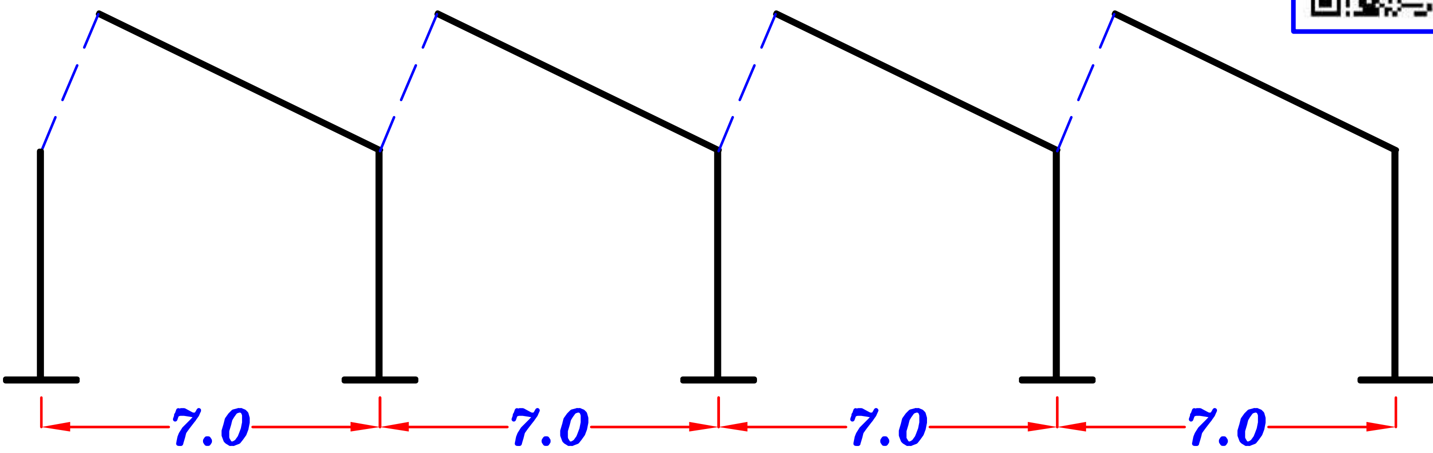
$\therefore$ *We have to put cantilever slab.*



$$\tan \alpha_{eff.} = \left(\frac{2.5}{4.5}\right) \longrightarrow \alpha_{eff.} = 29.05^\circ < 30^\circ$$

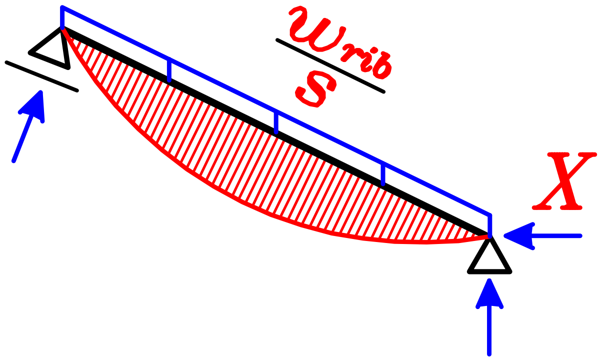
Example.

Without Tie

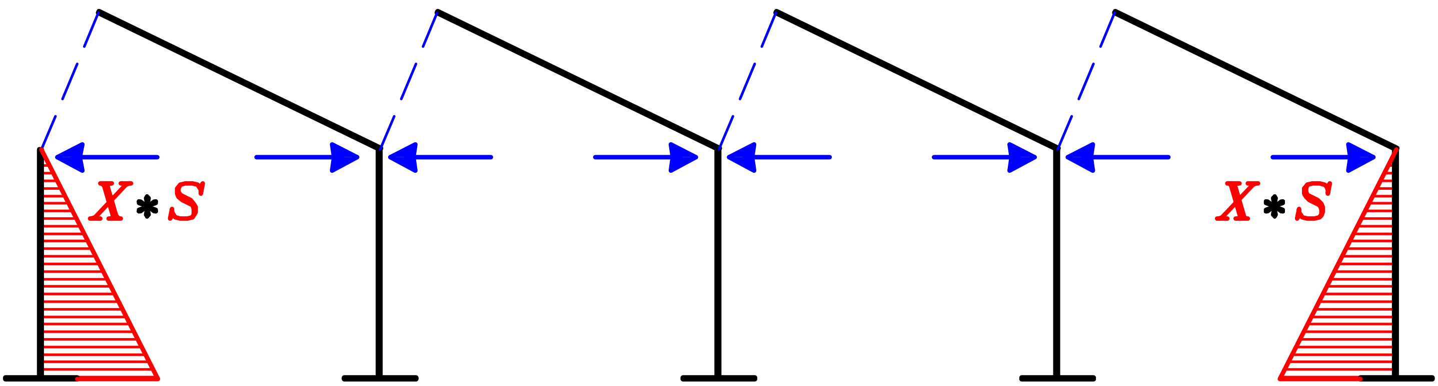


Choose a convenient Statical System and draw a sketch For an elevation Showing Concrete Dimensions.

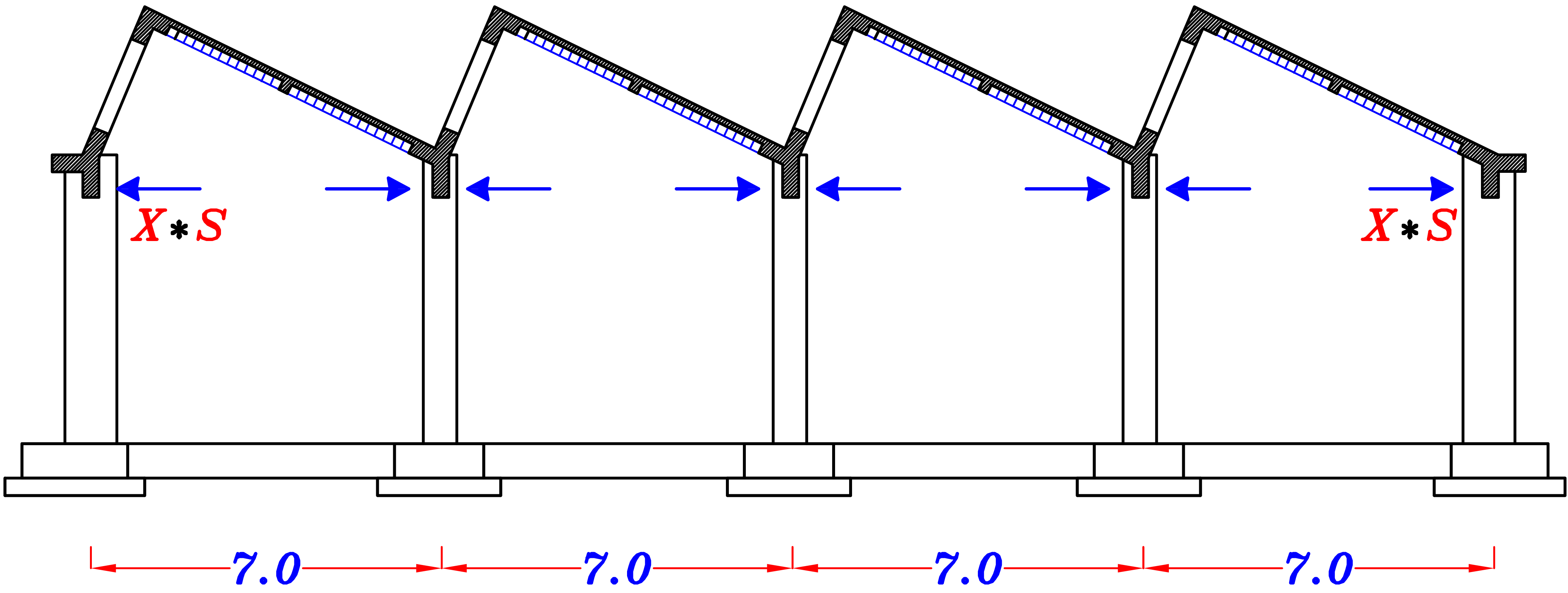
اذا لم توجد ال ***Tie*** و الشباك مائل فى ال ***Saw Tooth***



نأخذ شريحه فى البلاطه عرضها - ١,٠ م



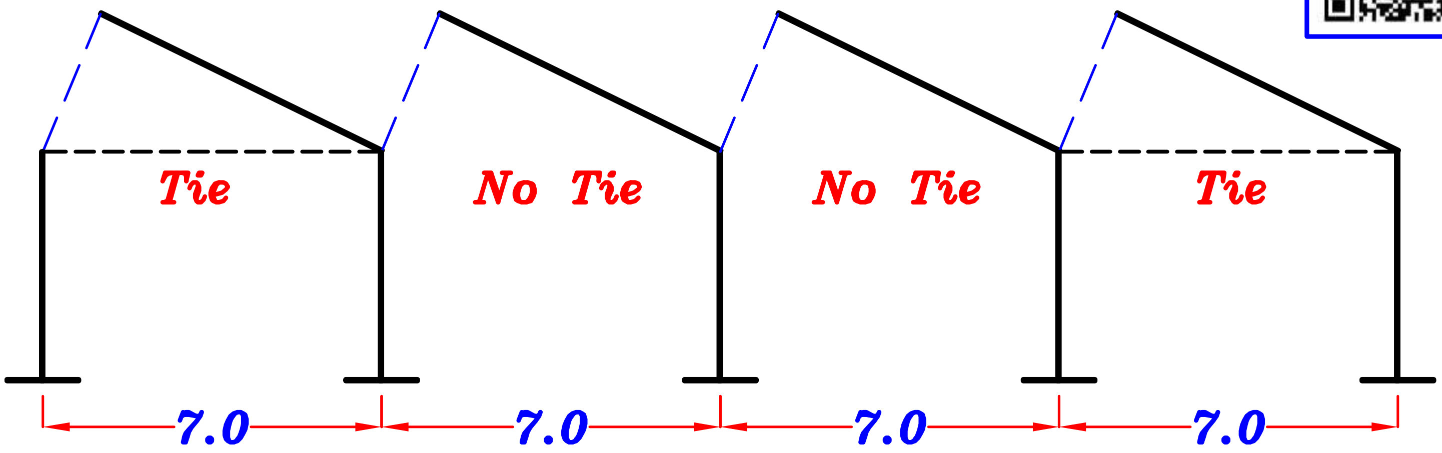
الاعمده فى الاطراف فقط عليها عزوم يتم ترحيل القواعد للخارج
و يتم الزياده من تخانه العمود
الاعمده فى المنتصف لا يوجد عليها عزوم فلا يتم ترحيل قواعدها



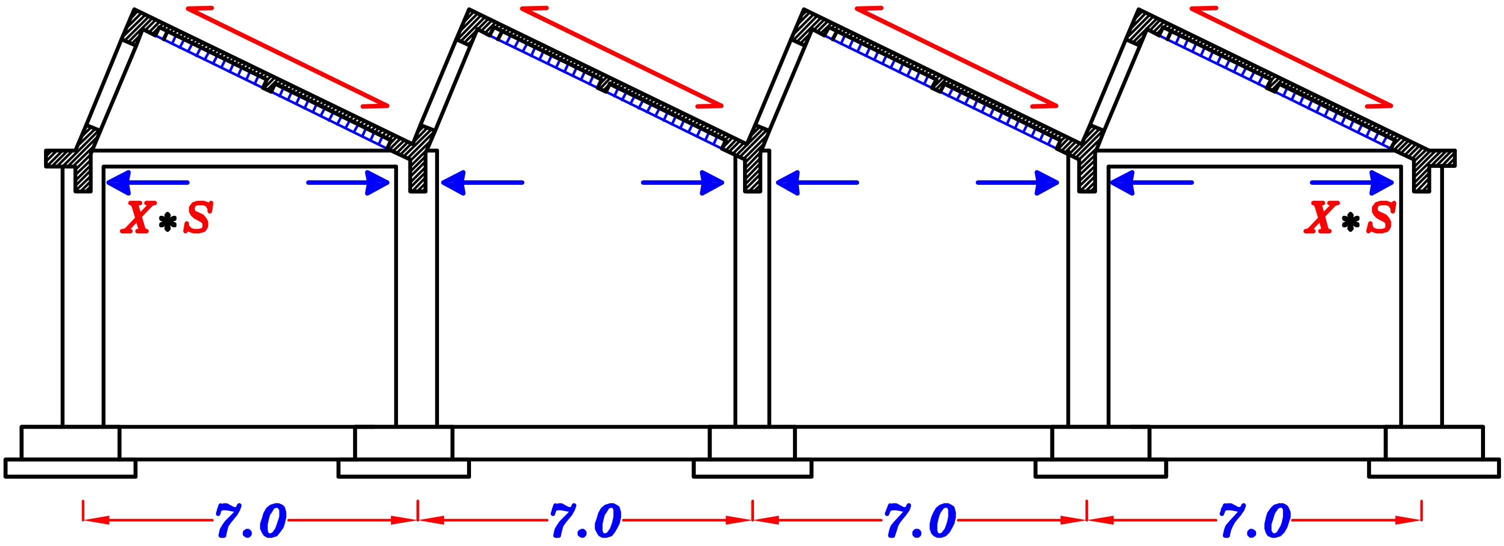
الاعمده فى الاطراف فقط عليها عزوم يتم ترحيل القواعد للخارج و يتم الزياده من تخانه العمود

الاعمده فى المنتصف لا يوجد عليها عزوم فلا يتم ترحيل قواعدها .

Example.



Choose a convenient Statical System and draw a sketch For an elevation Showing Concrete Dimensions.

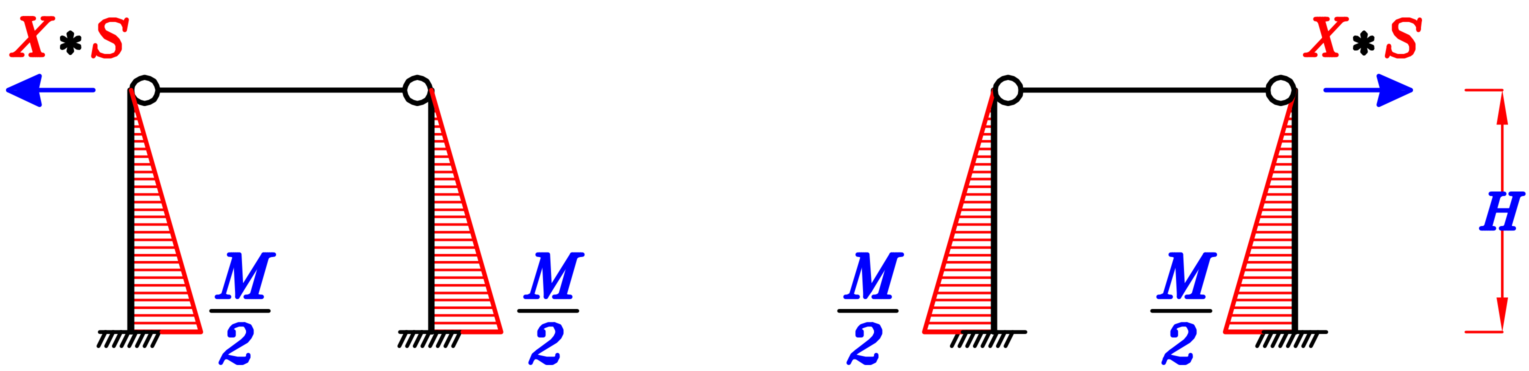


اذا تم ازاله ال Tie فى الباكيتين اللتان فى المنتصف فقط.

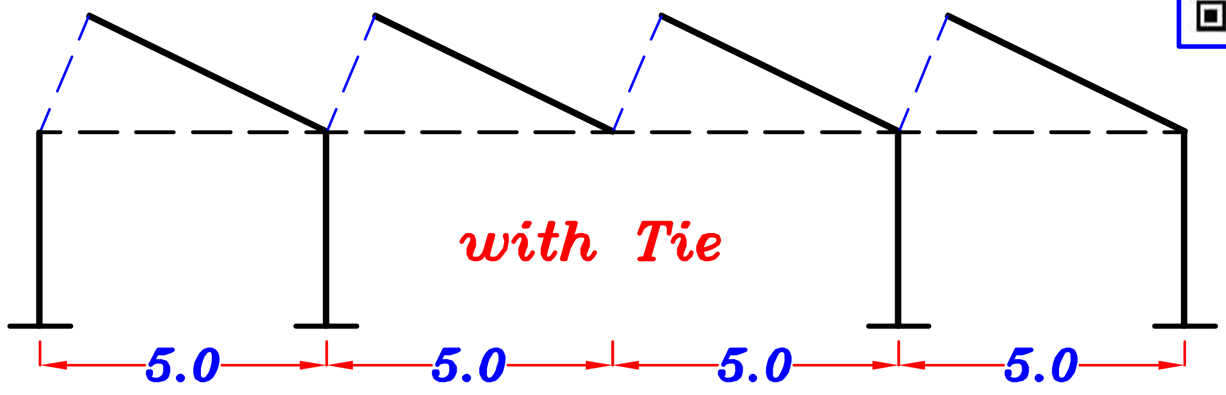
ستكون كل Tie فى الاطراف غير متزنه داخليا فى اتجاه X

لذلك سيتكون عزم تتوزع على الاعمده بالتساوى .

$$\boxed{M = (X*S)*H}$$

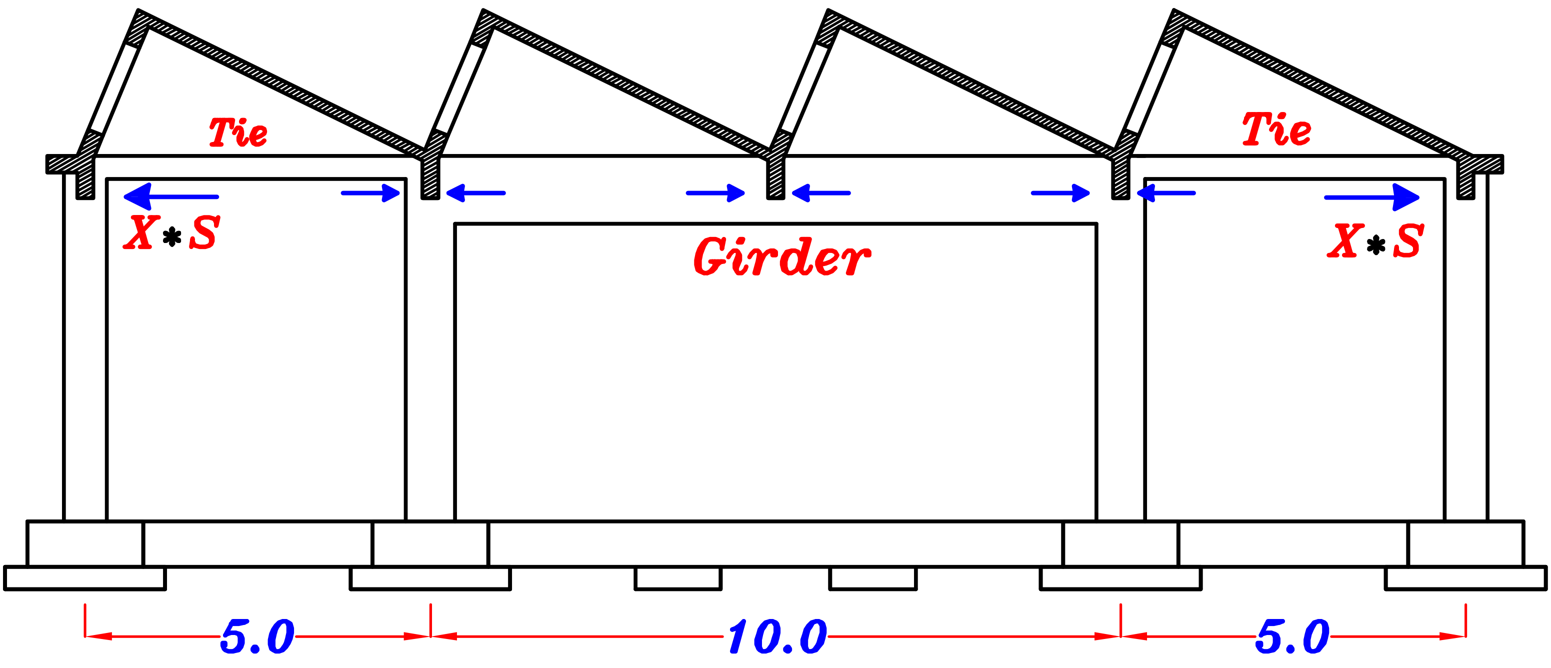


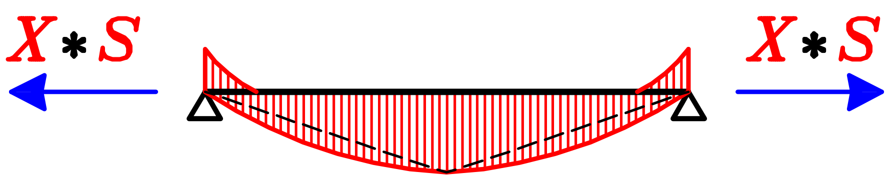
Example.



Choose a convenient Statical System and draw a sketch For an elevation Showing Concrete Dimensions.

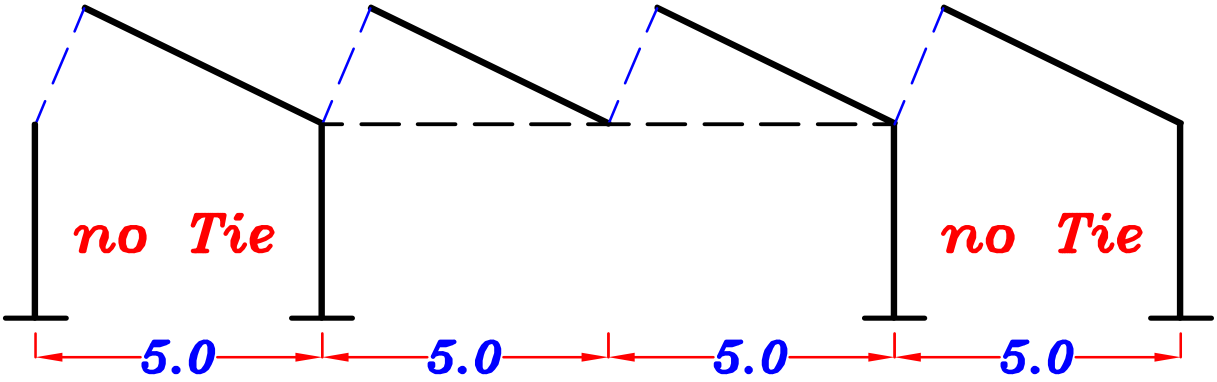
يتم وضع *Girder* حتى نتمكن من حمل ال *Y–Beam* التى فى المنتصف .





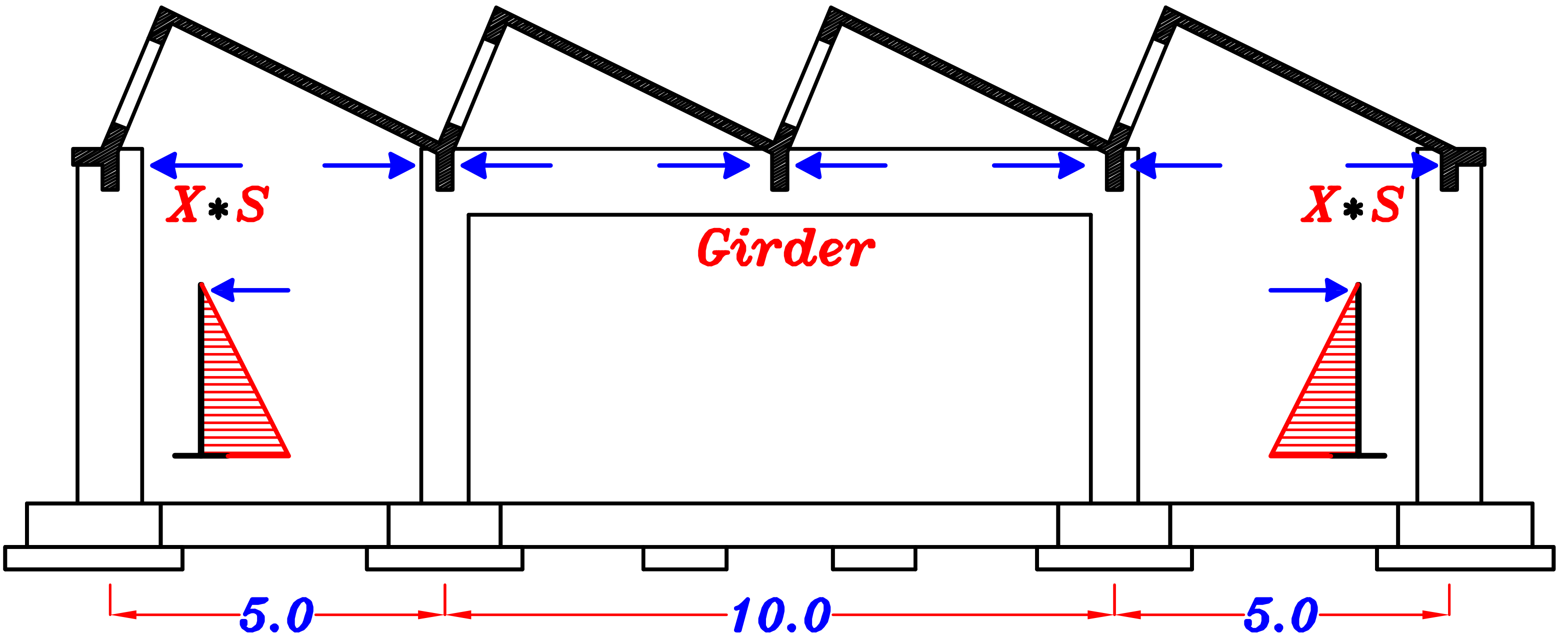
توجد قوى شد على ال *Girder* تساوى $(X*S)$ فيتم التصميم على *M,T*

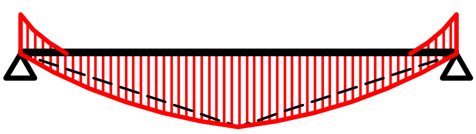
Example.



Choose a convenient Statical System and draw a sketch For an elevation Showing Concrete Dimensions.

يتم وضع **Girder** حتى نتمكن من حمل ال **Y-Beam** التى فى المنتصف .





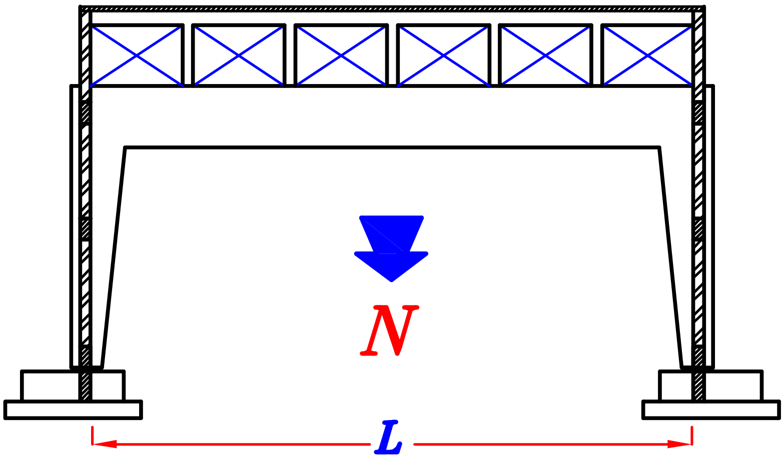
لا توجد قوى شد على ال **Girder** فيصمم على **M** فقط

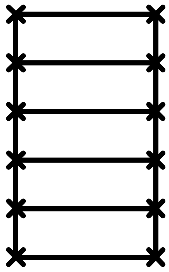
الاعمده فى الاطراف فقط عليها عزوم يتم ترحيل القواعد للخارج

و يتم الزياده من تخانه العمود

Saw Tooth Slab Type Rested on Frame.

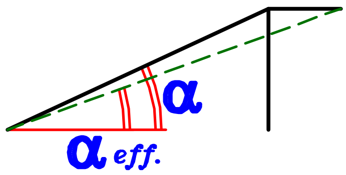
الشباك موازى لل Frame





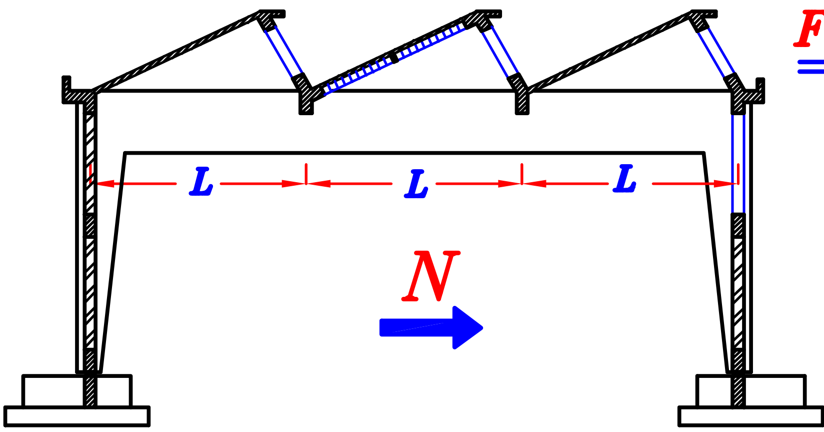
North

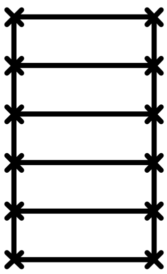
(β=0.0) يجب أن يكون الشباك رأسى



* **Slabs.** One Way S.S. → $L \leqslant 6.0$ m
  One Way H.B. → $L = (6.0 \rightarrow 8.0)$ m
* **Inclination of slab.** $(\alpha_{eff.}) = (20 \rightarrow 30^\circ)$ مع الأفقى
* **Posts** (250×250)
  Distance between Posts $(a) = (2 \rightarrow 3)$ m

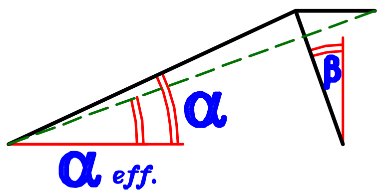
الشباك عمودى على ال Frame





North

ممكن وضع شباك مائل



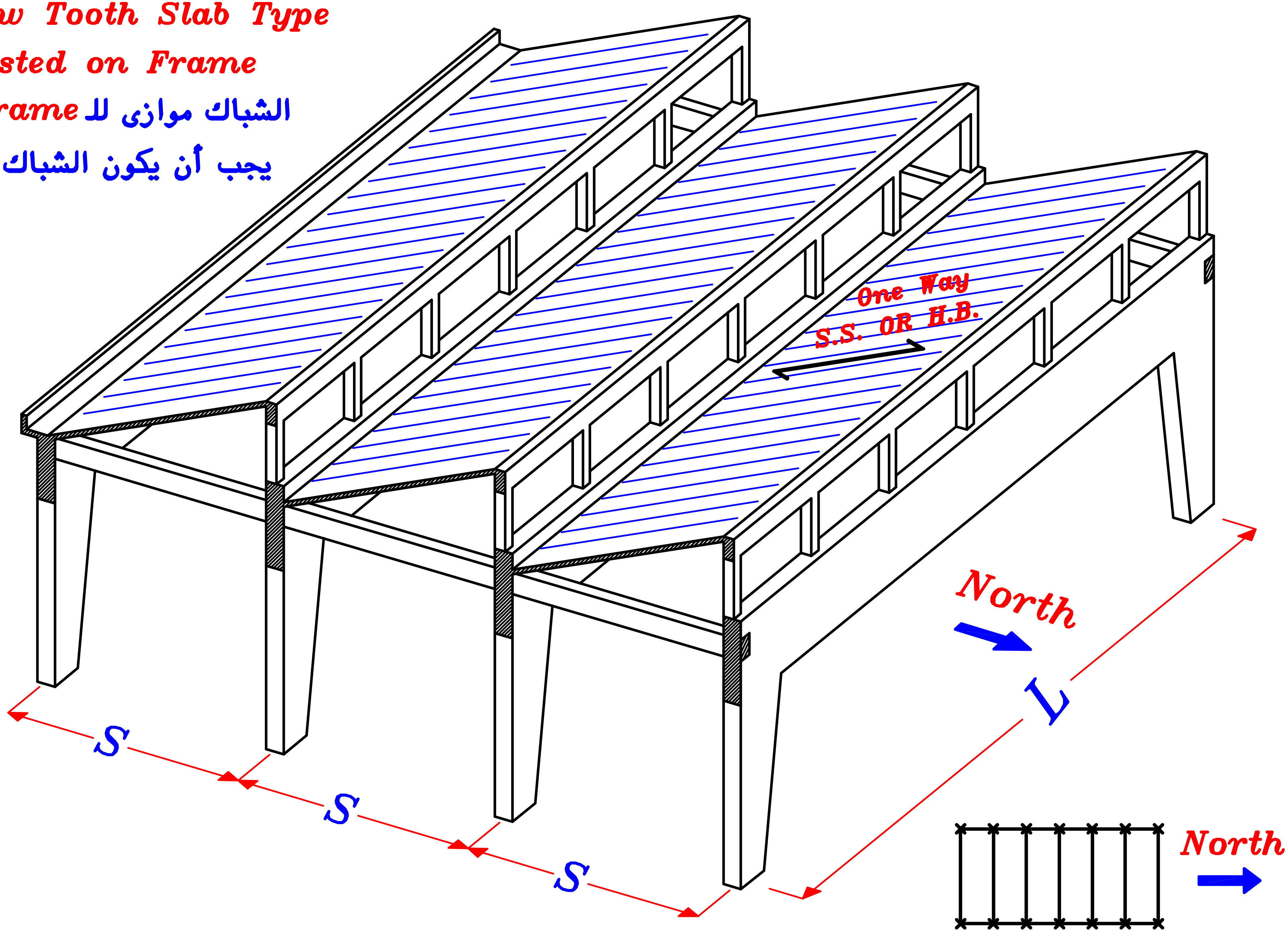
* $(L) = (4 \rightarrow 8)$ m
* **Slabs.** One Way S.S. → $L \leqslant 6.0$ m
  One Way H.B. → $L = (6.0 \rightarrow 8.0)$ m
* **Inclination of slab.** $(\alpha_{eff.}) = (20 \rightarrow 30^\circ)$ مع الأفقى
* **Inclination of Post.** $(\beta) = (0 \rightarrow 15^\circ)$ مع الرأسى
* **Posts** (250×250)
  Distance between Posts $(a) = (2 \rightarrow 3)$ m

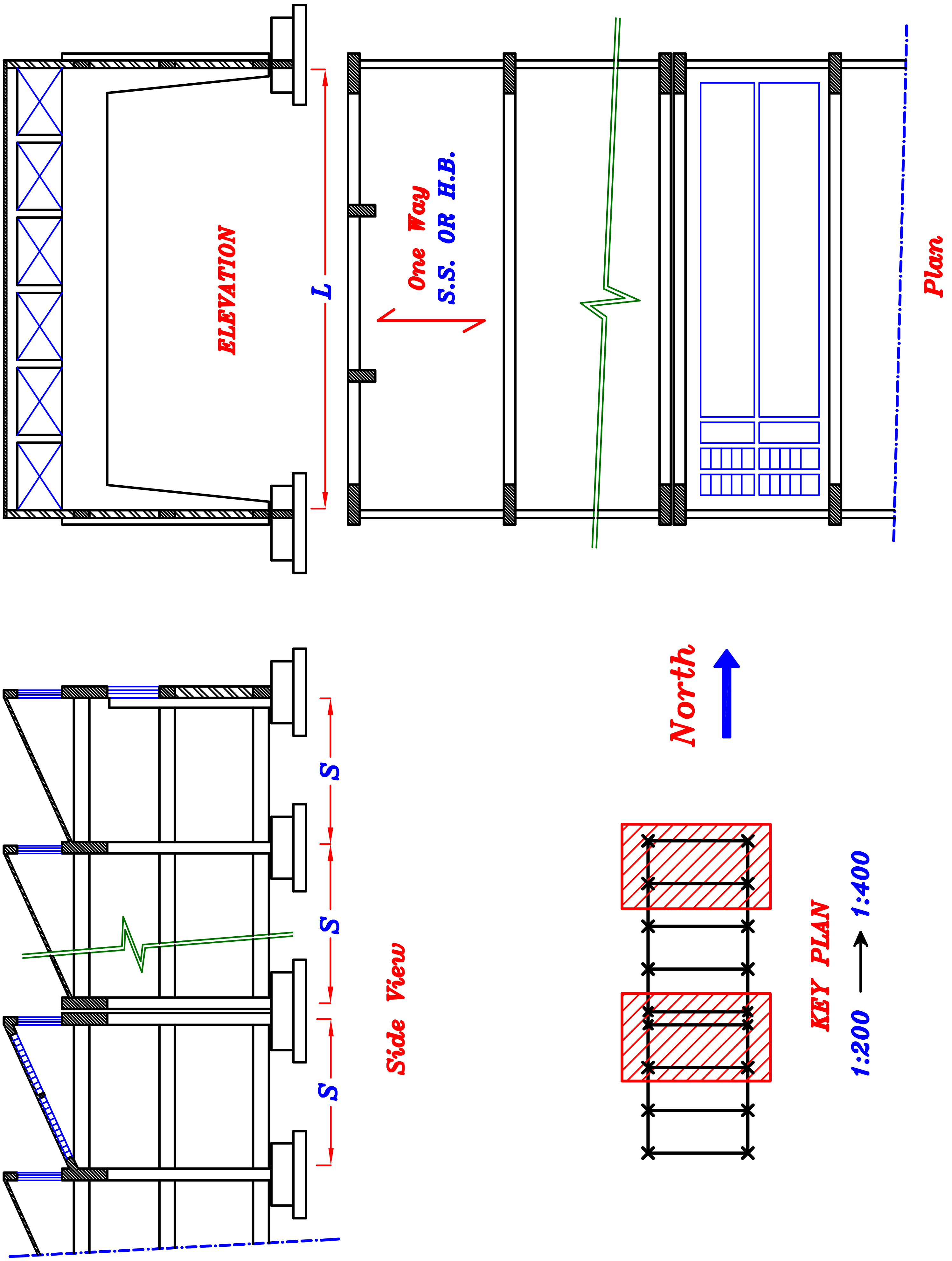
Saw Tooth Slab Type

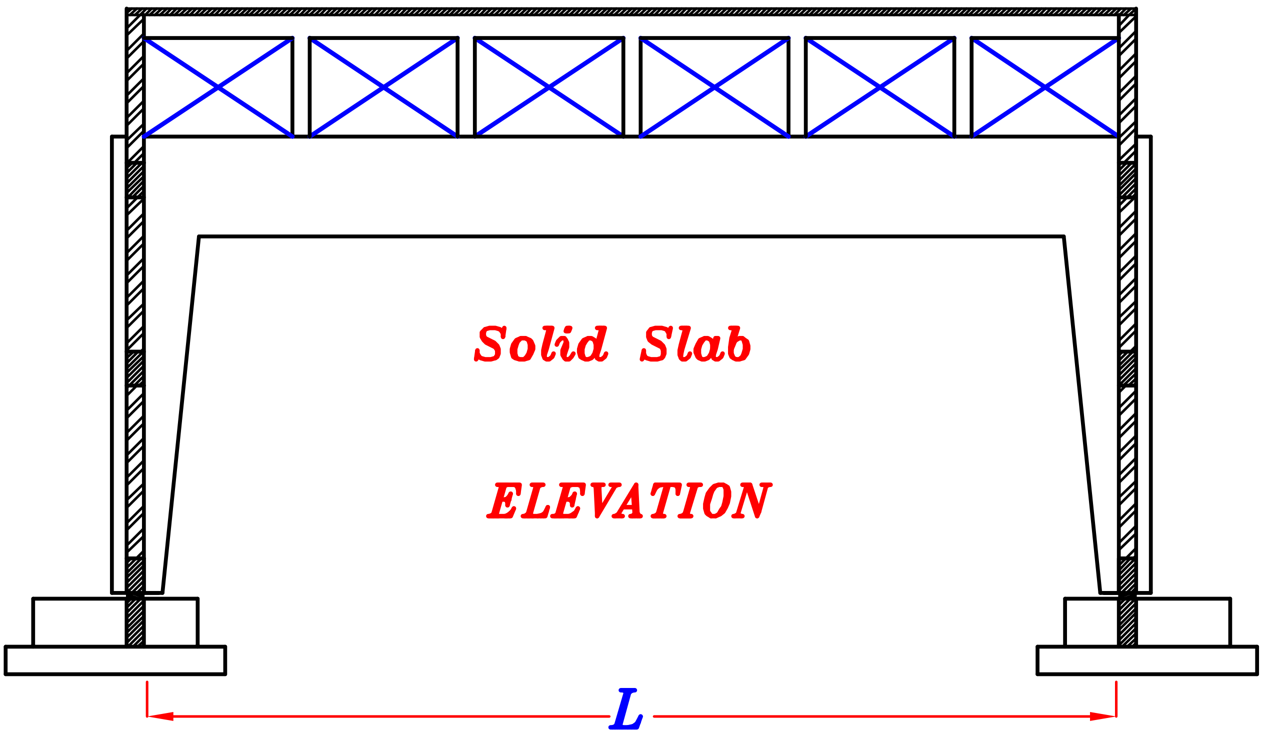
Rested on Frame

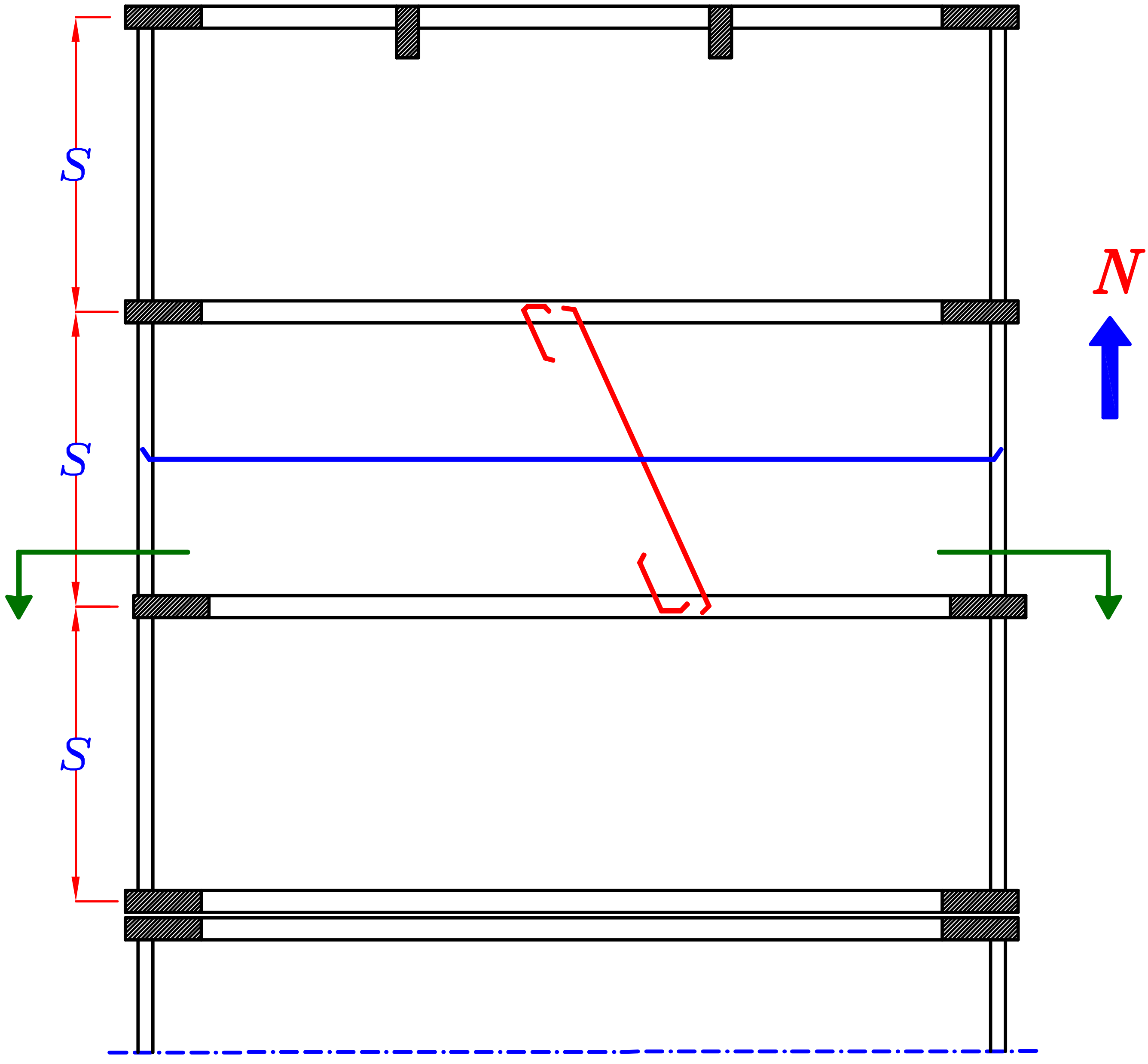
الشباك موازى للFrame

يجب أن يكون الشباك رأسى

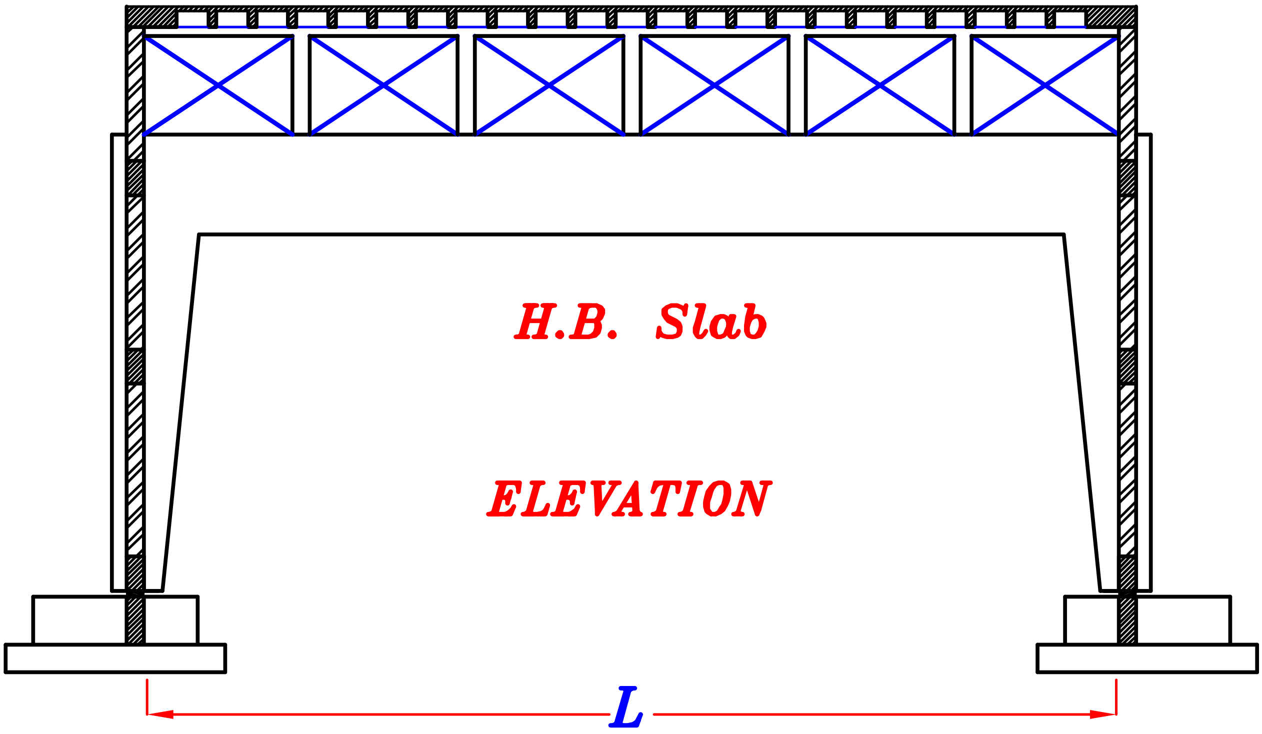


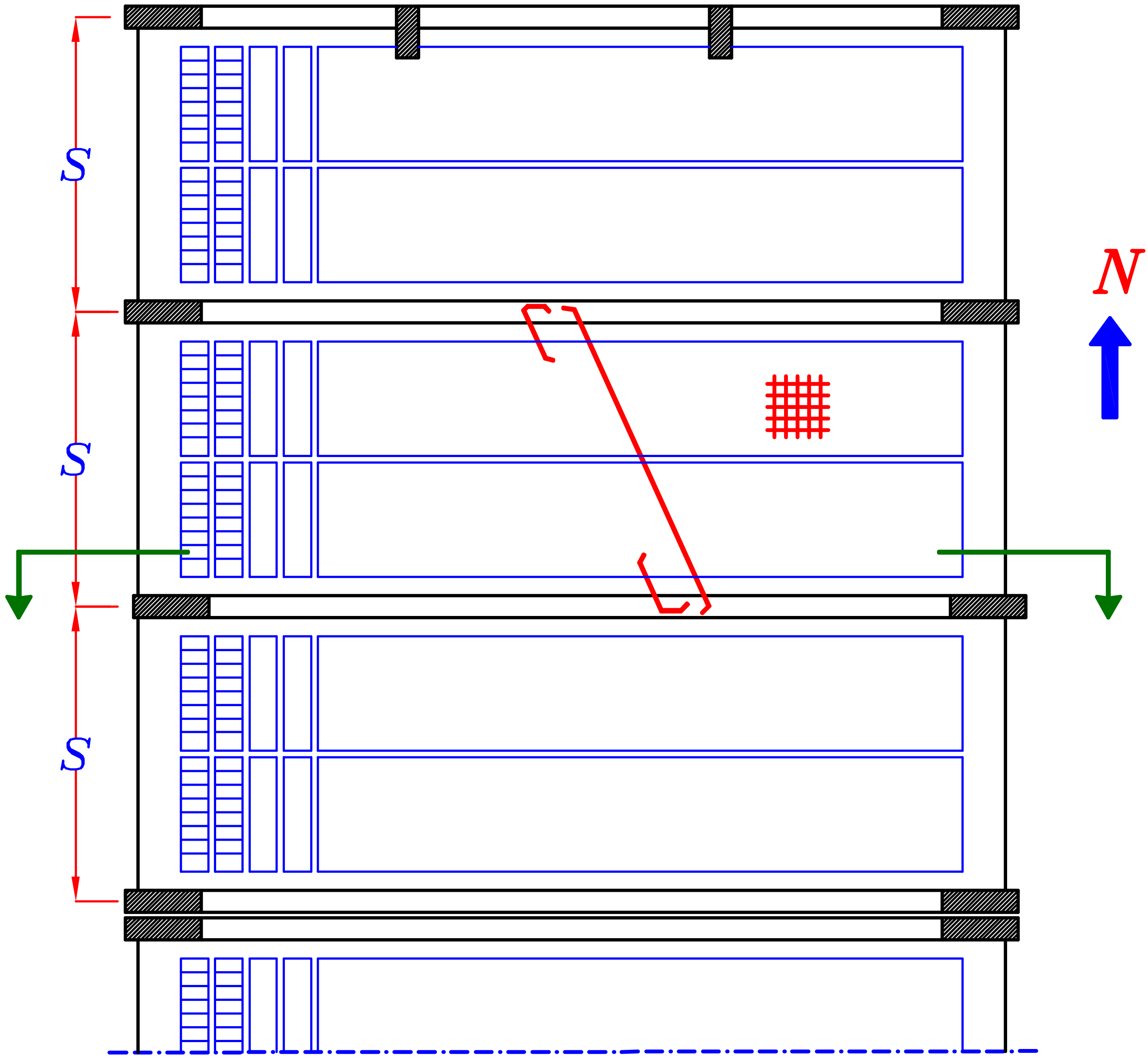

ELEVATION
L
One Way
S.S. OR H.B.
Plan
S
S
S
Side View
North
KEY PLAN
1:200 → 1:400





Plan


H.B. Slab
ELEVATION
L

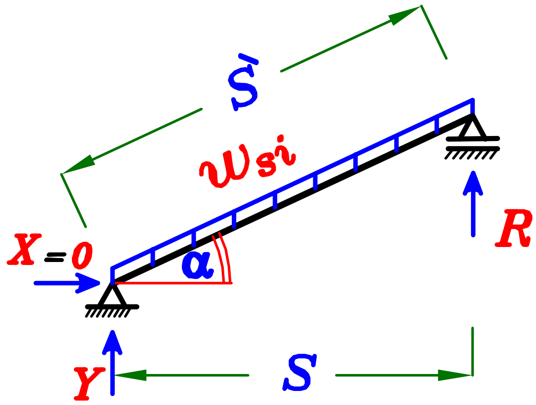

S
S
S
N
Plan

Statical System.

* Loads From Slab.

$$w_s = 1.4\,(t_s\,\gamma_c + F.C.) + 1.6\ L.L.\ \cos\alpha$$

$$Y = R = \frac{w_s * S'}{2}$$

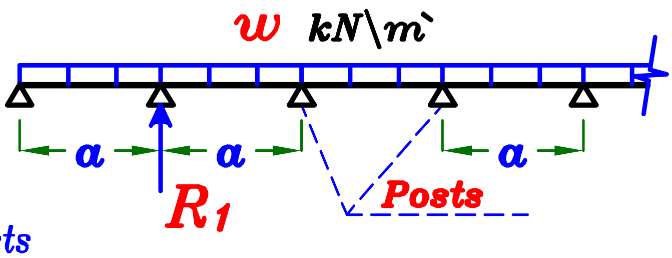


* Loads on Ridge Beam.

$$w = O.W._{(beam)} + R \qquad kN\backslash m`$$

$$a = (2 \longrightarrow 3)\ m \qquad \textit{Distance Between Posts}$$

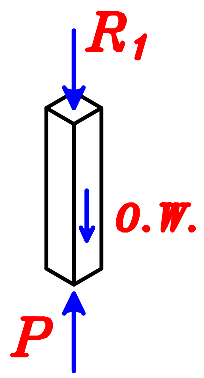
$$R_1 = w * a$$



* Loads on The Post.

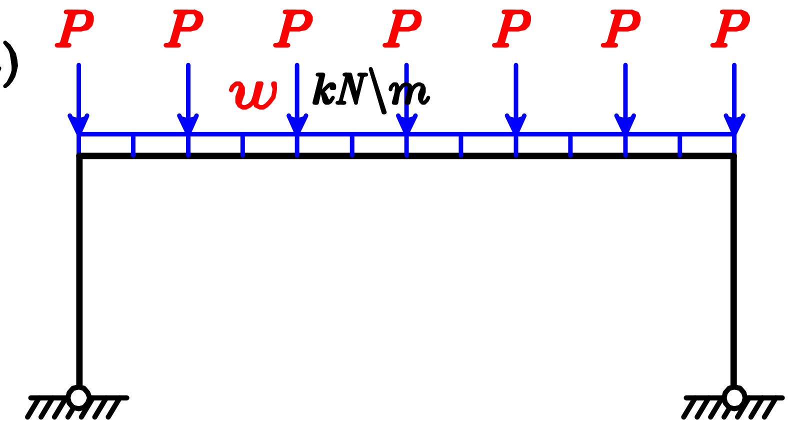
$$P = O.W._{(Post)} + R_1$$

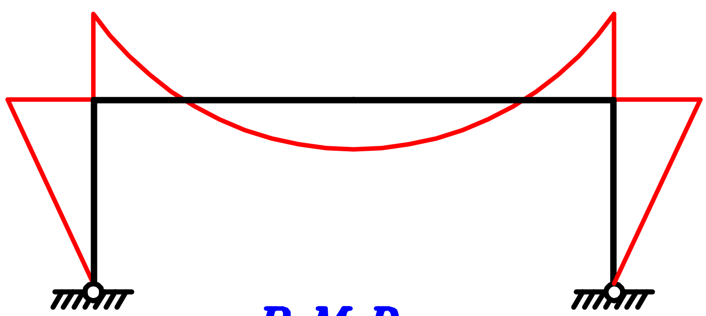
$$O.W._{(Post)} \simeq 3.50\ kN\ (U.L.)$$



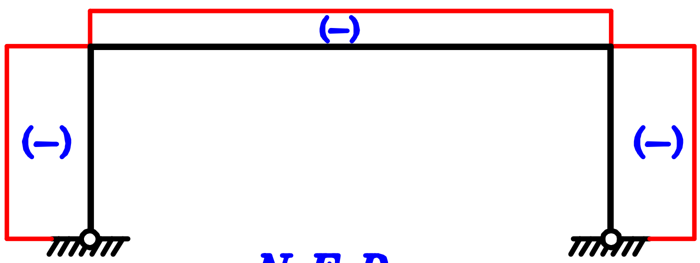
* Loads on The Frame.

$$w = O.W._{(Frame)} + Y \quad (kN\backslash m)$$



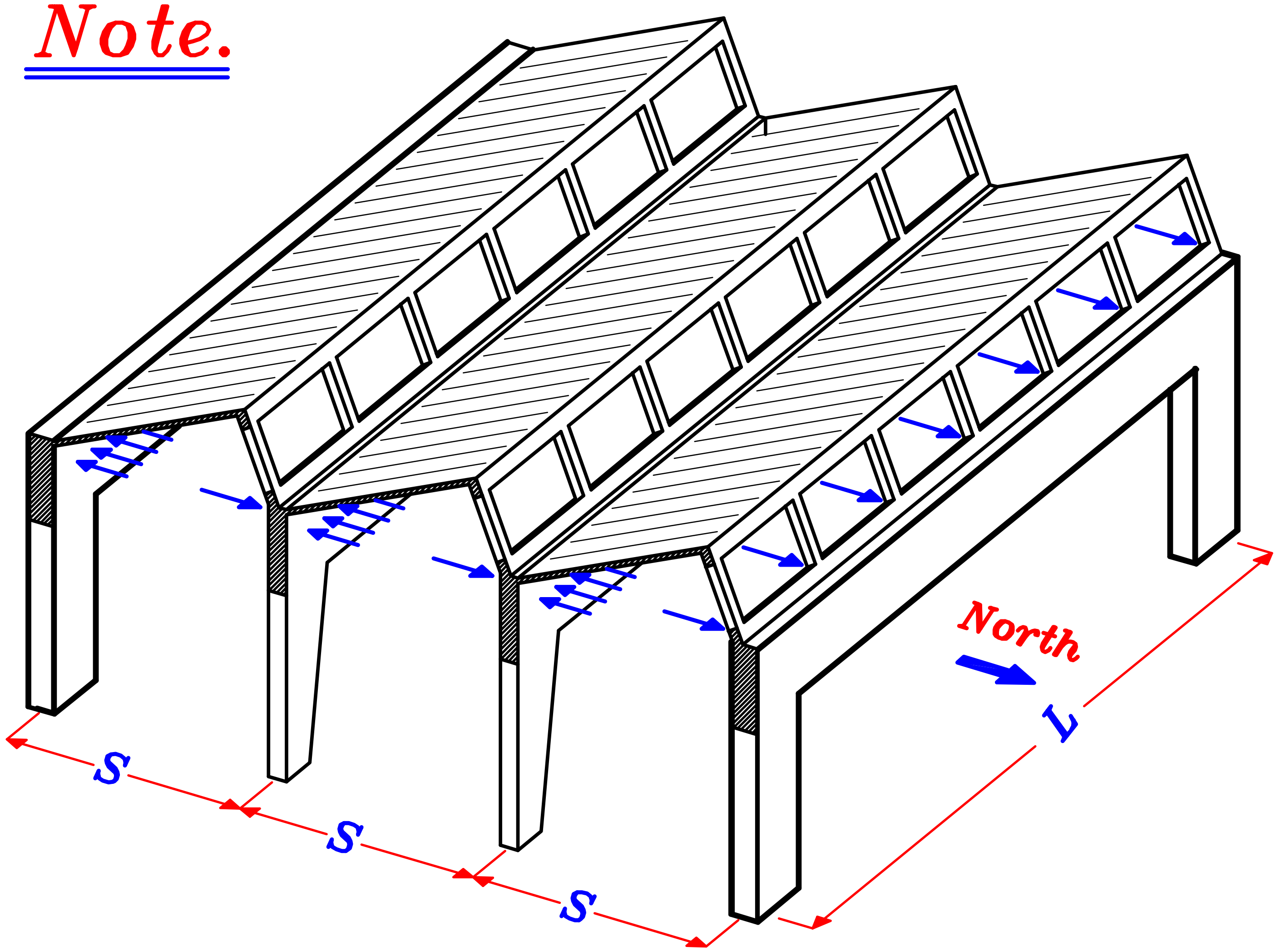


B.M.D.



N.F.D.

Note.



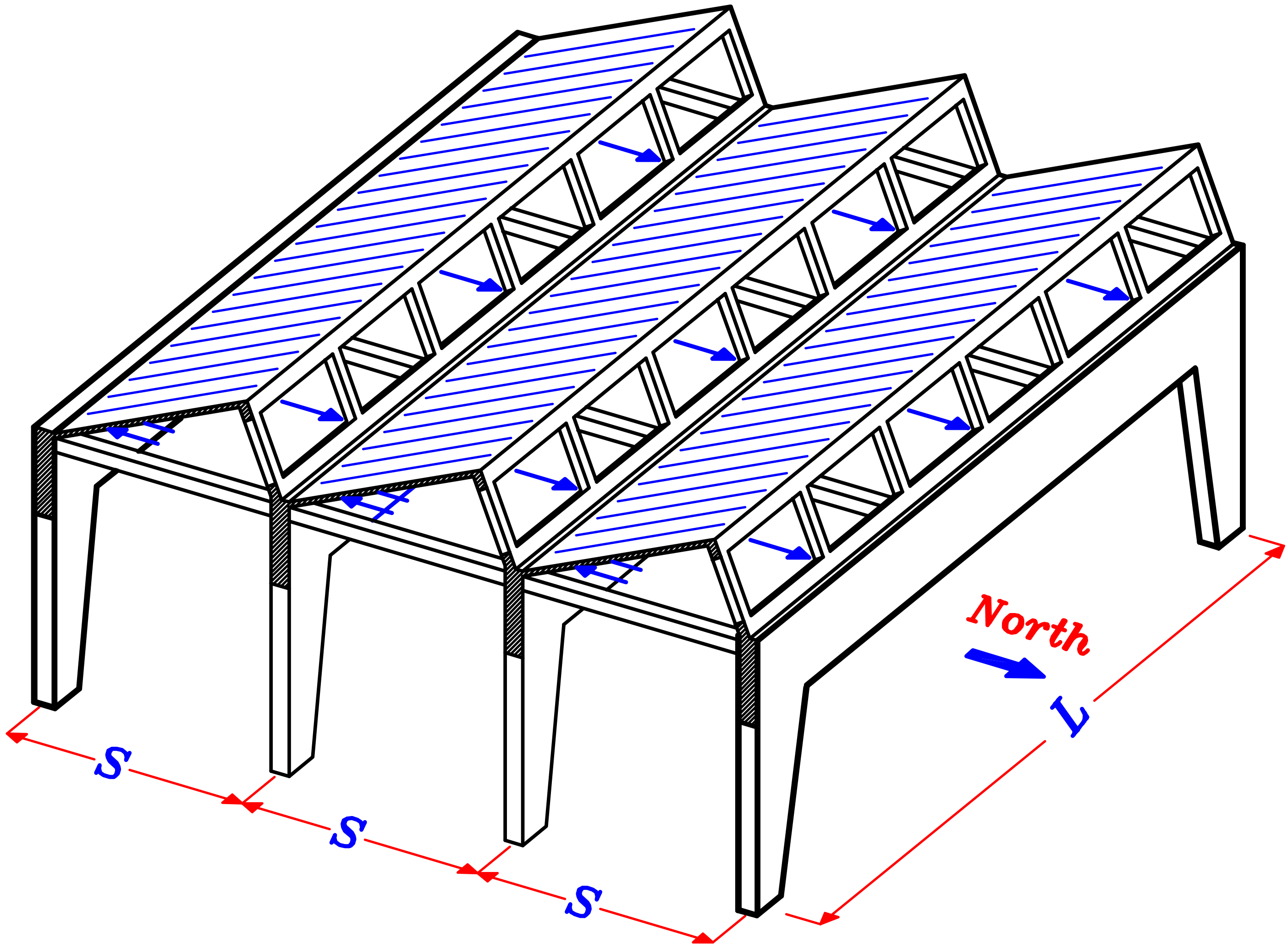
عندما يكون شباك ال **Saw Tooth** فى نفس اتجاه ال **Frame** لكن مائل تكون هناك قوى أفقيه فى الاتجاه العمودى على ال **Frames**

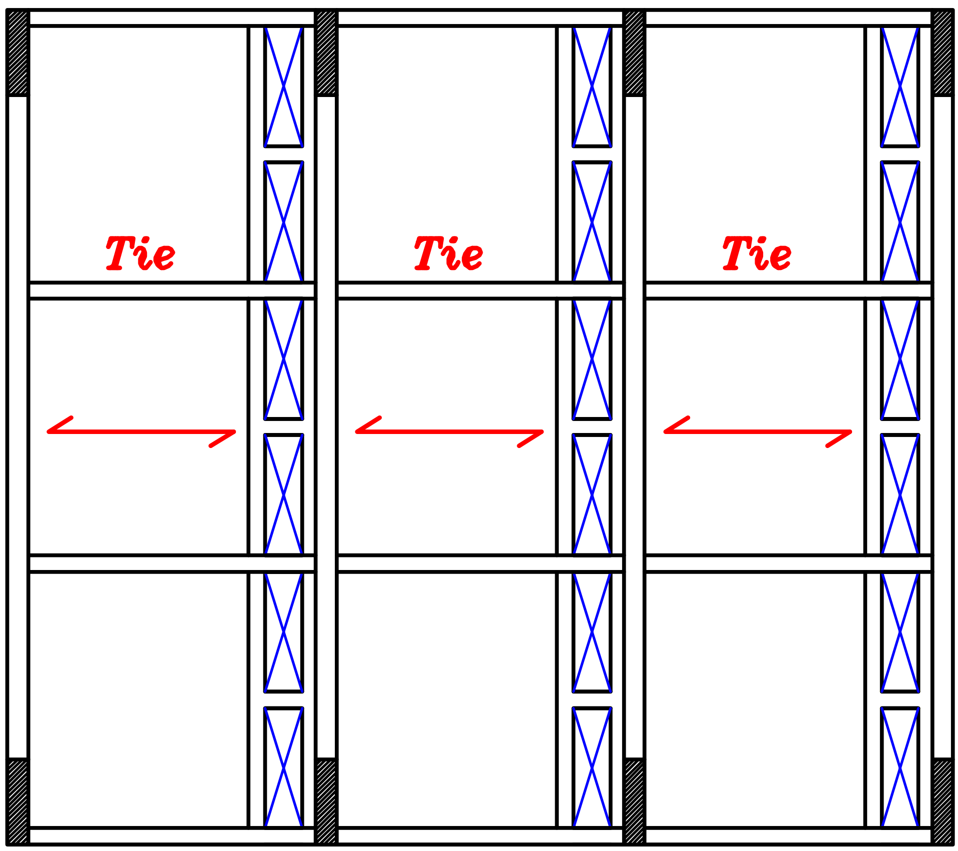
و لكن تأثيرها على ال **Frames** المتكرره يكون بسيط لوجود قوى افقيه عكسها مثل ال **(Y-Beam)**

لكن أول و أخر **Frame** سيؤثر عليه قوه أفقيه من جهه واحده .

و لمقاومه القوى الافقيه على أول و أخر **Frame** يتم عمل حل من الحلين التاليين

١- يتم وضع *Tie* كل عدد من الشبابيك لتقليل العزم الافقى على أول و أخر *Frame*



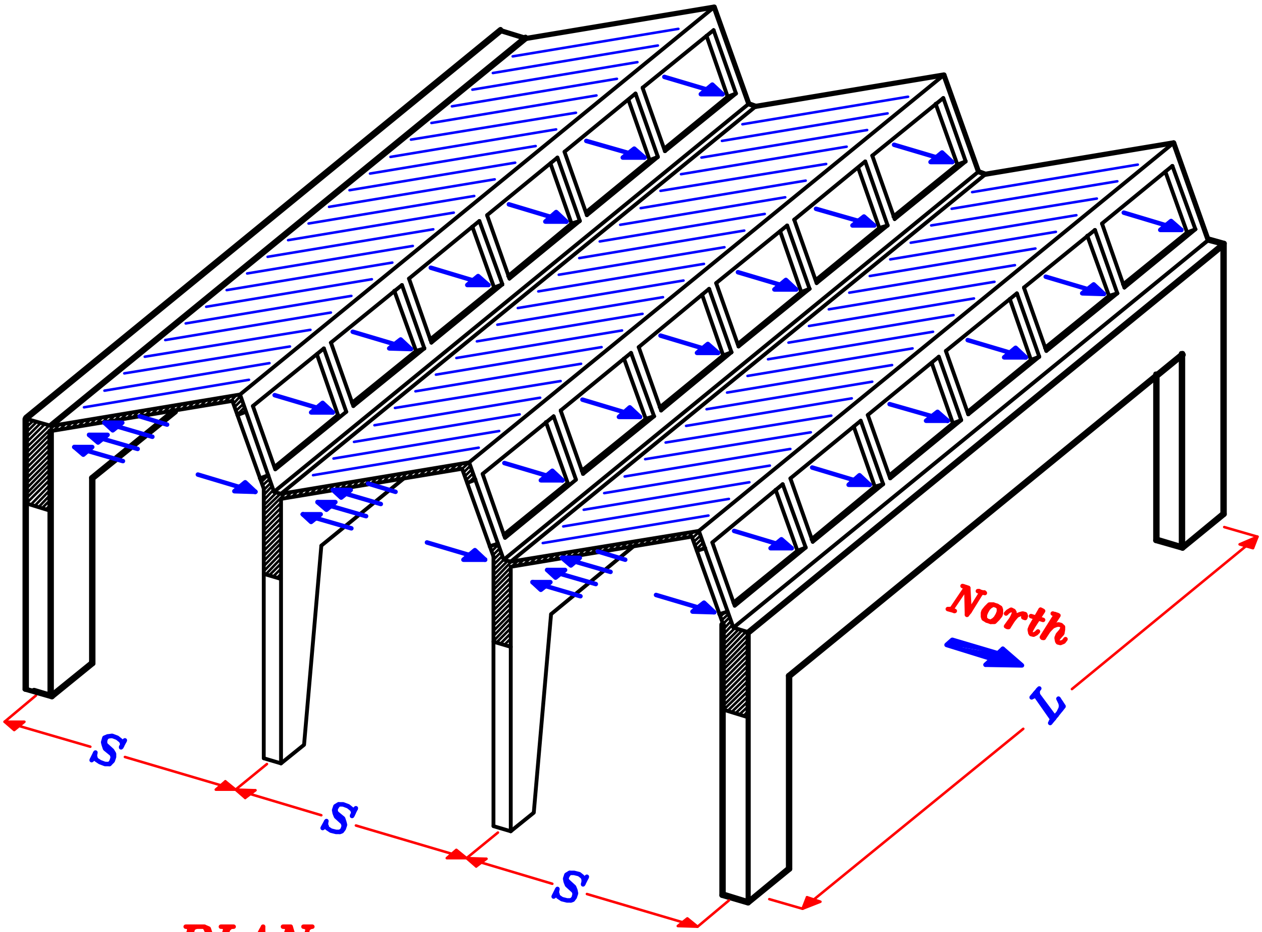


PLAN

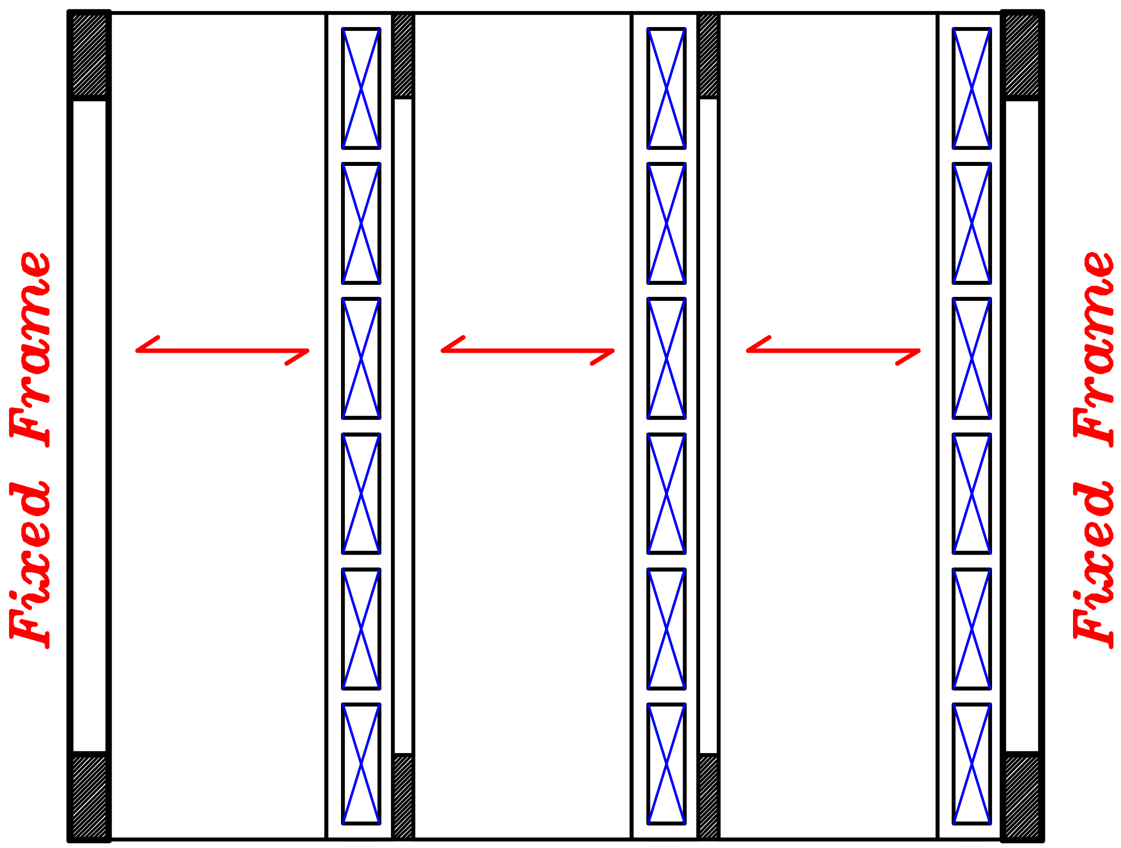
٢ـ يتم تحويل أول و أخر **Frame** الى **Fixed Frame**

و يجب تكبير العرض **b** $b=500\,mm$

و عند تصميم هذا ال **Frame** يتم تصميمه على عزم رأسى و أفقى معا **Bi-Axial moment**



PLAN

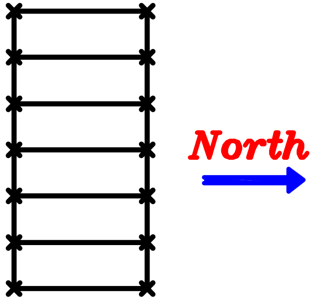


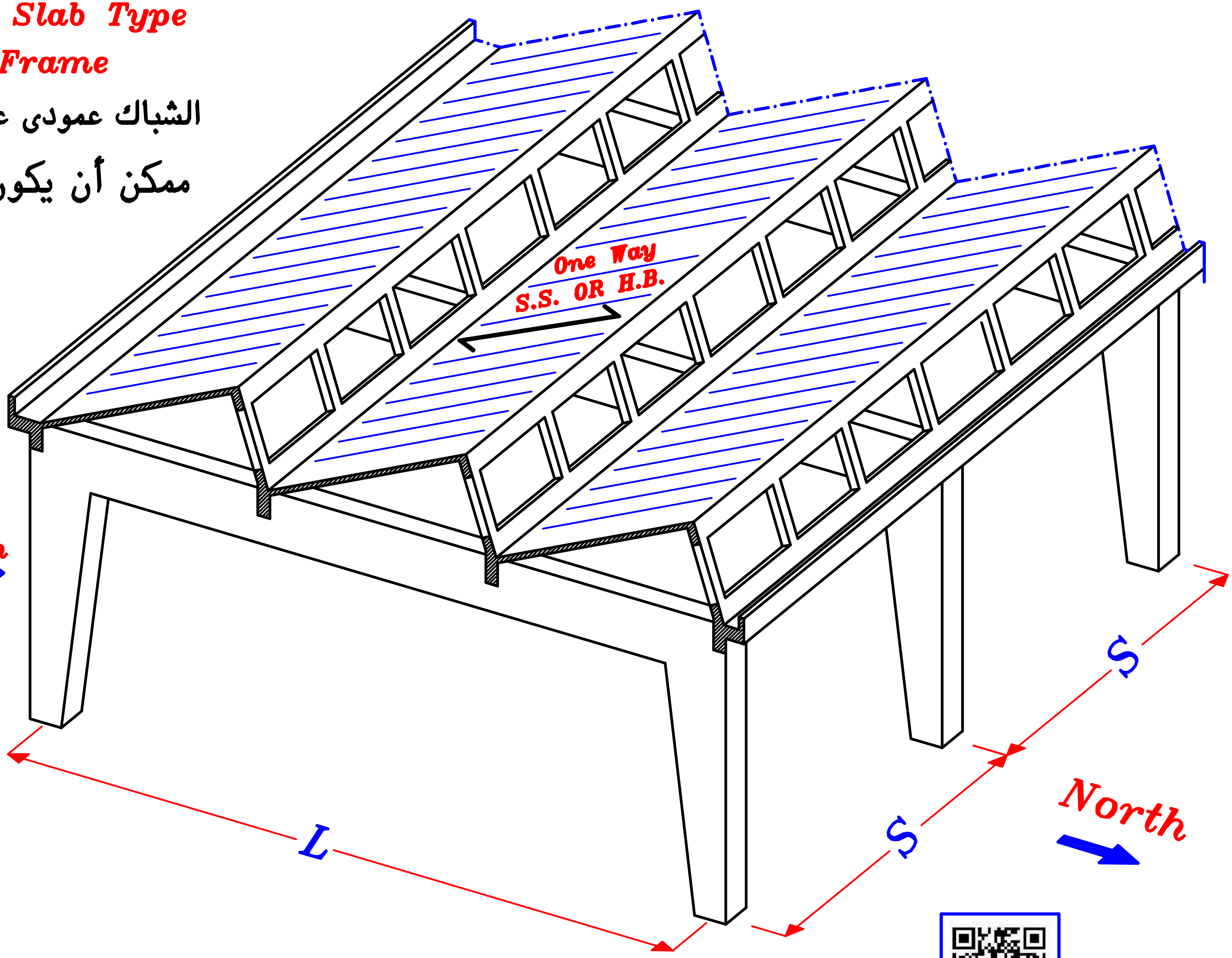
Saw Tooth Slab Type

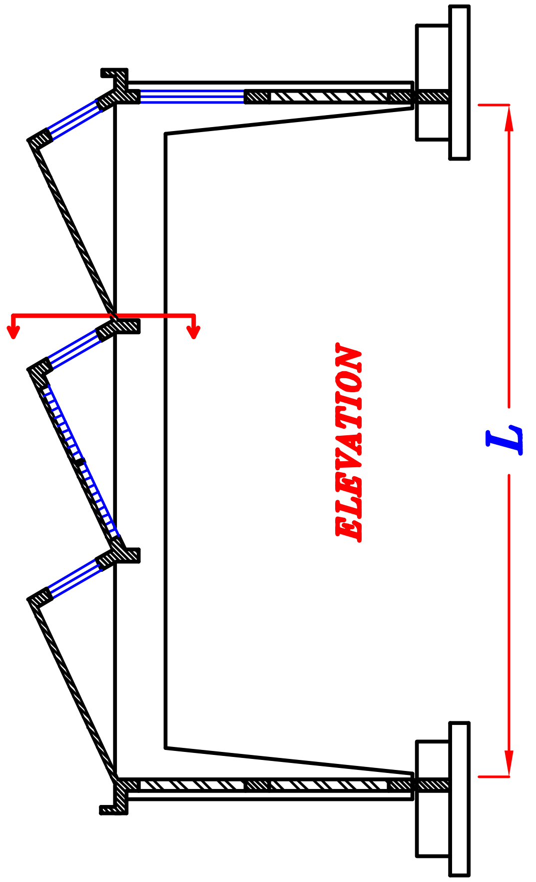
Rested on Frame

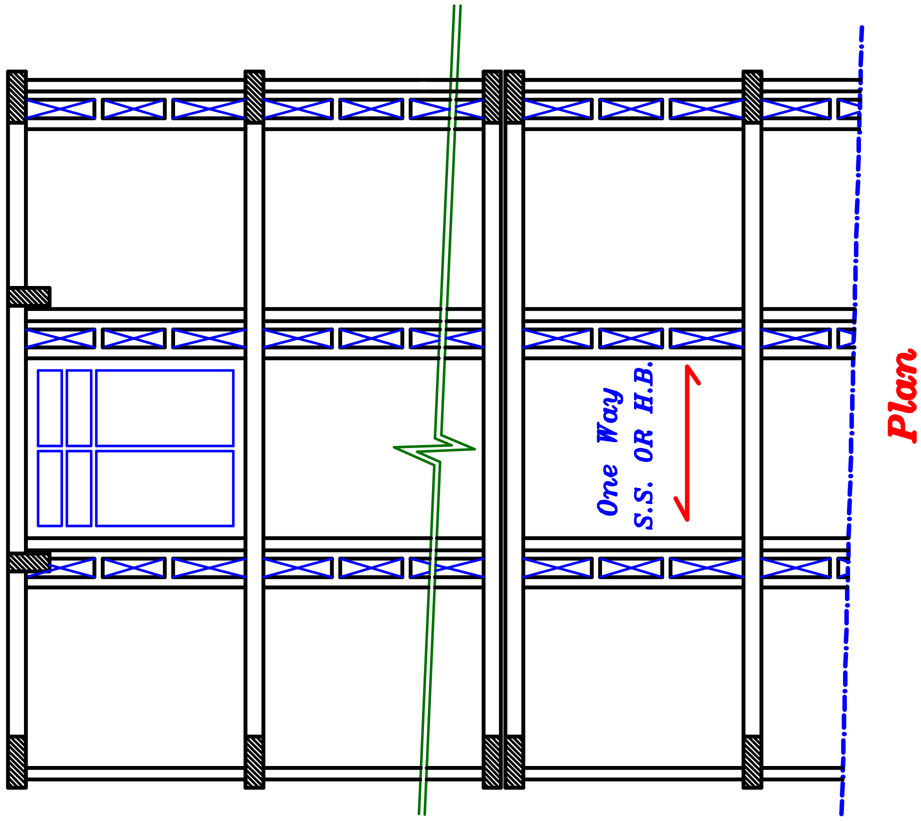
Frame الشباك عمودى على الـ

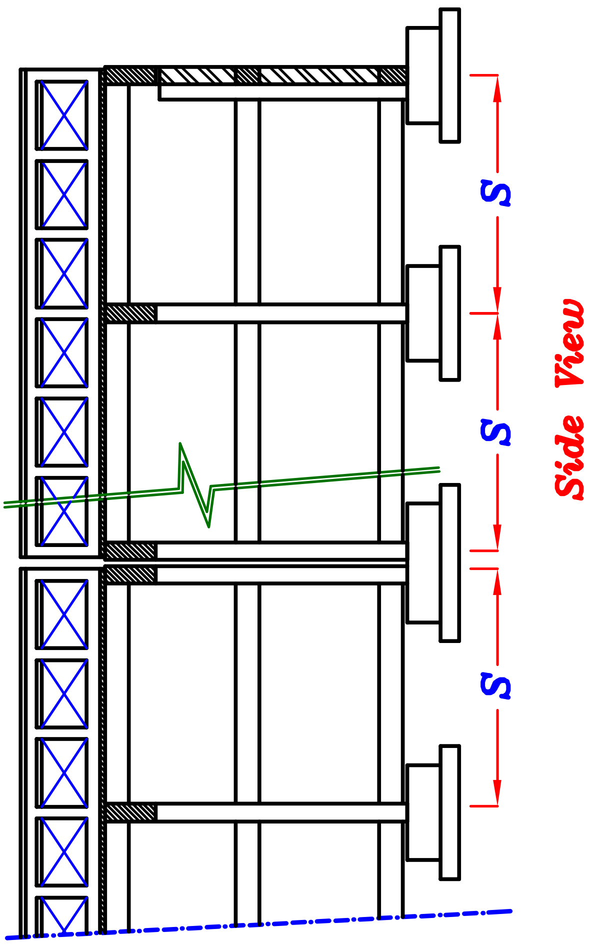
ممكن أن يكون الشباك مائل

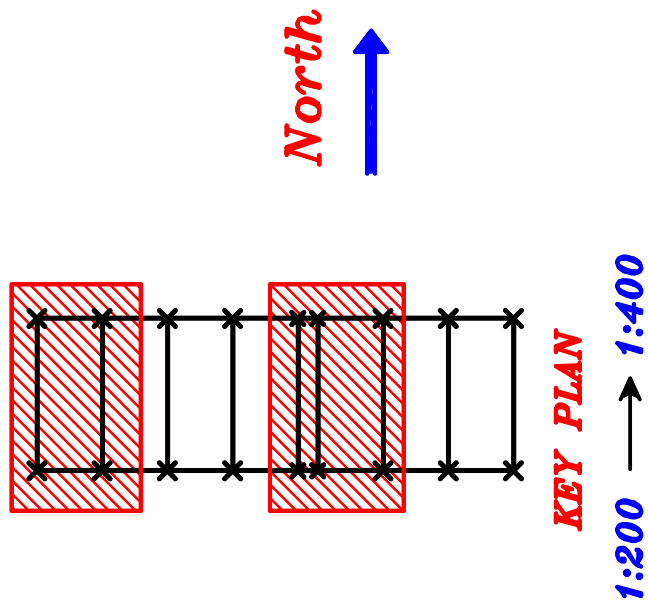


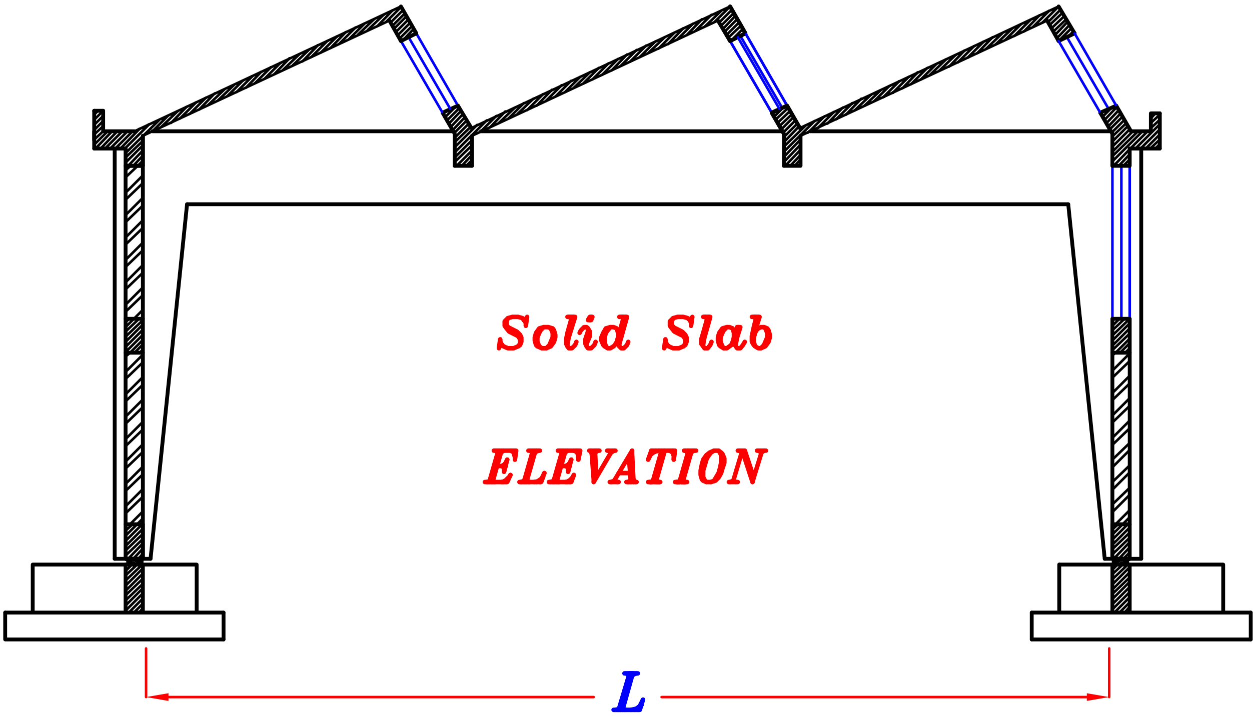


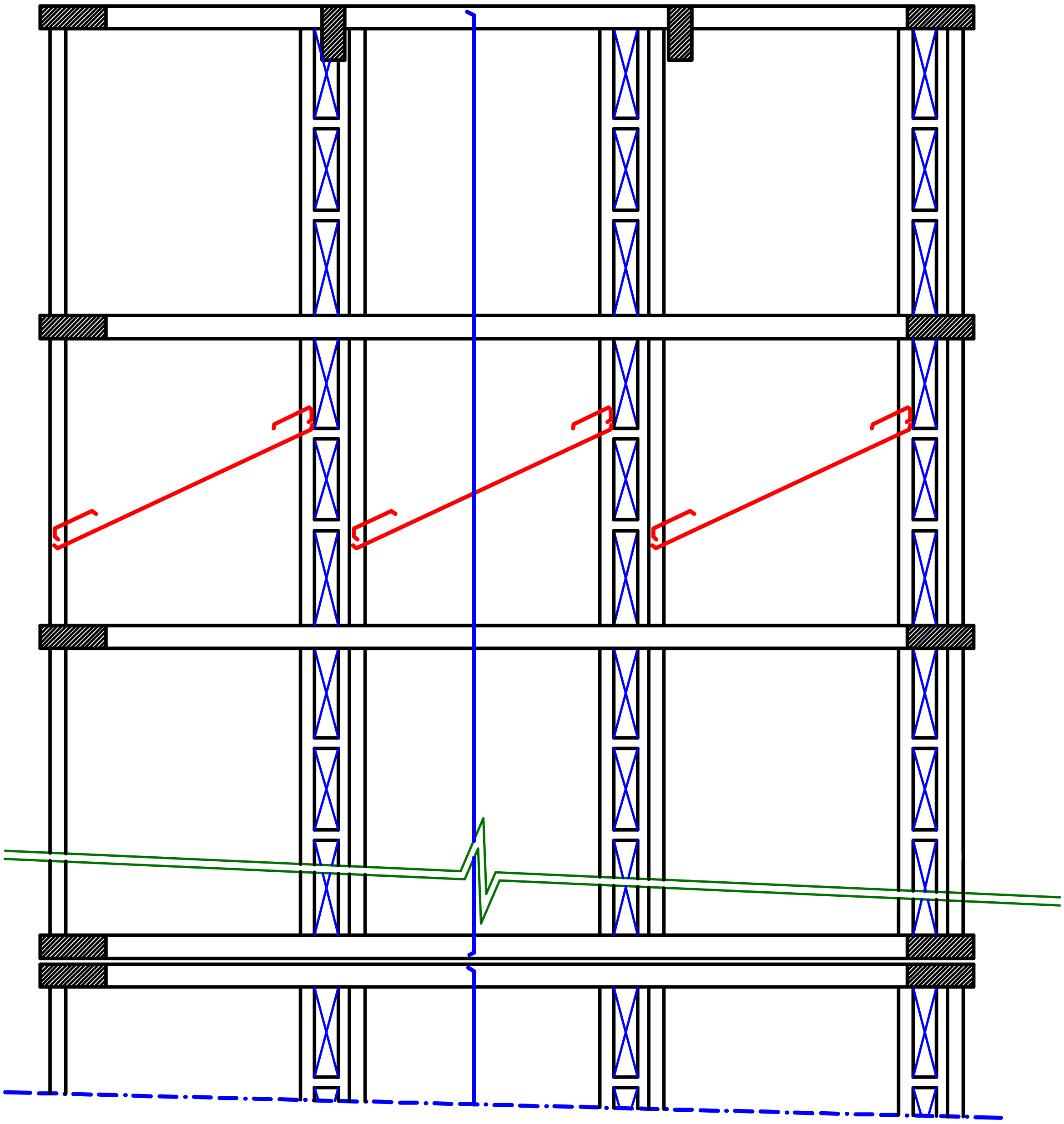

ELEVATION
L


Plan
One Way
S.S. OR H.B.

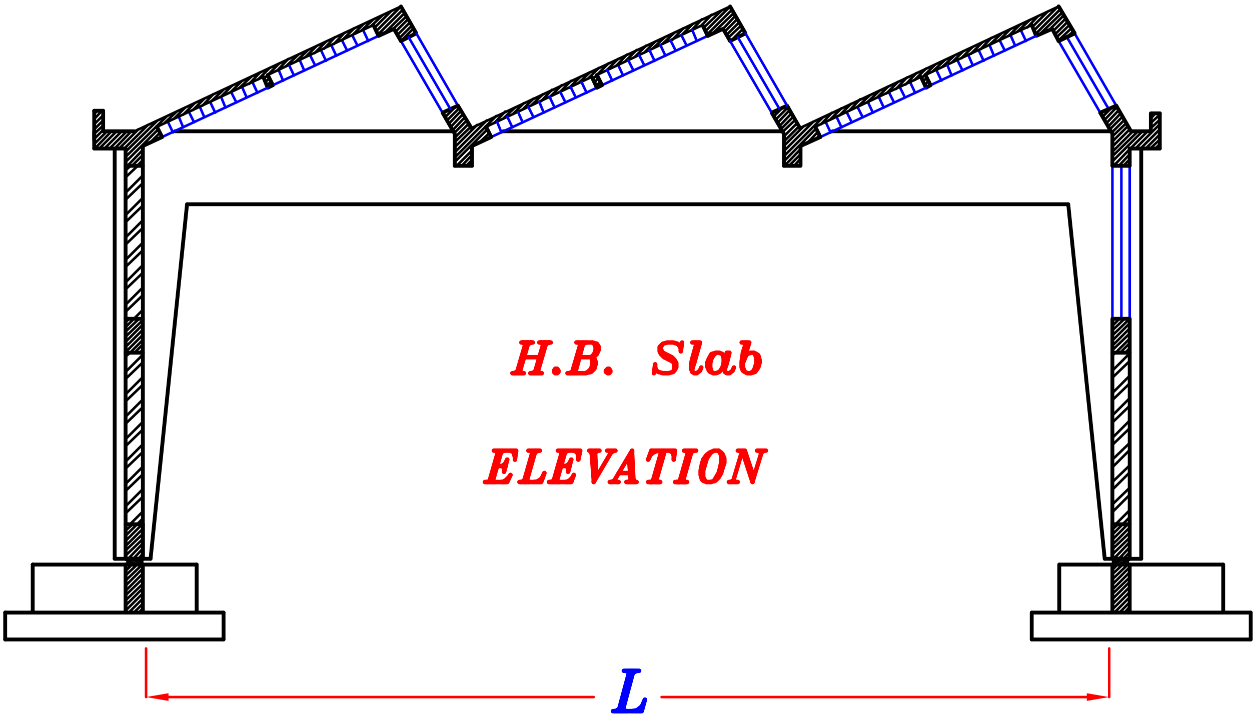

Side View
S
S
S

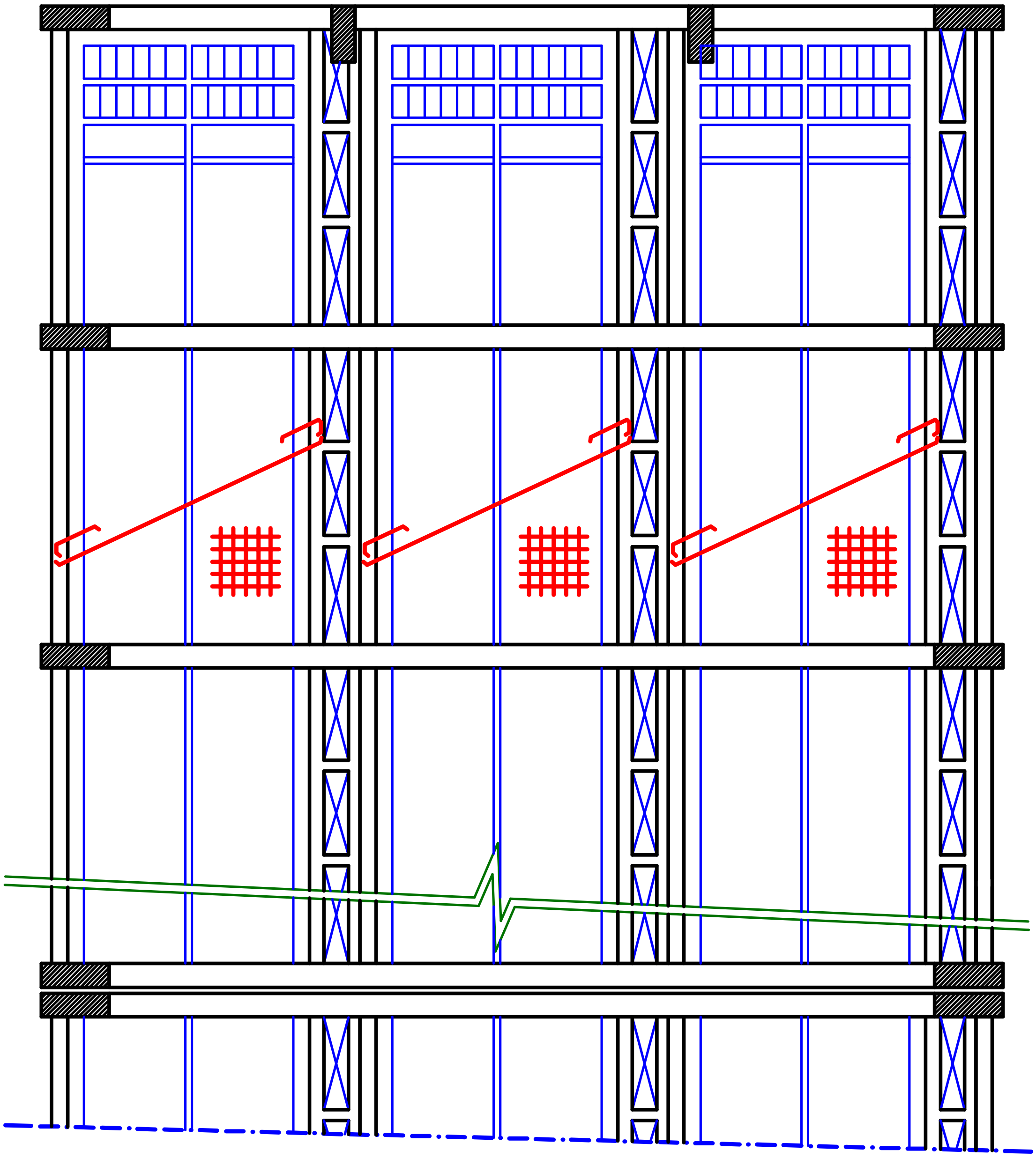

North
KEY PLAN
1:200 → 1:400





Plan

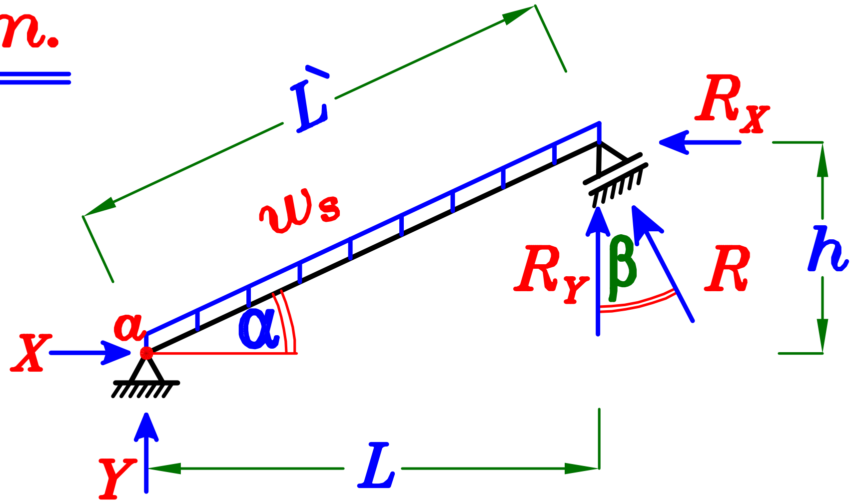




Plan

Statical System.

* Loads From Slab.



$$w_S = 1.4\,(t_s\,\gamma_c + F.C.) + 1.6\ L.L.\ \cos\alpha$$

To Get the Reactions. Using Equations.

$$R_Y = R\cos\beta \quad , \quad R_X = R\sin\beta$$

$\because \sum M_a = Zero \qquad w_s\,L`\left(\frac{L}{2}\right) - R_Y(L) - R_X(h) = 0.0$

$\therefore\ w_s\,L`\left(\frac{L}{2}\right) - R\cos\beta\,(L) - R\sin\beta\,(h) = 0.0 \longrightarrow$ Get $R = \checkmark$

$\therefore\ R_Y = R\cos\beta = \checkmark \quad , \quad R_X = R\sin\beta = \checkmark$

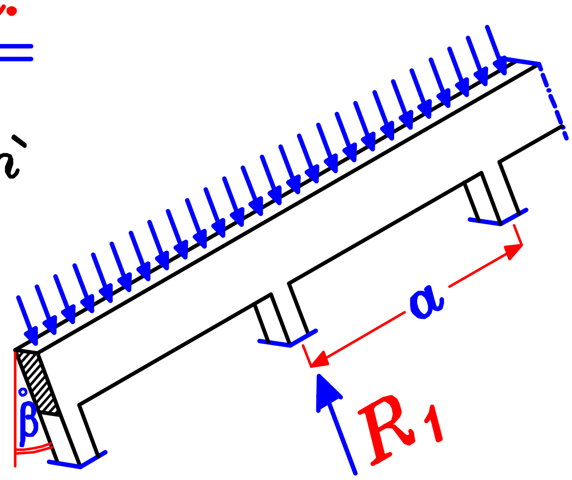
$\therefore\ X = R_X \quad ,$ Get Y From $\sum Y = Zero$

* Loads on the Ridge Beam.

$$w = O.W._{(beam)} * \cos\beta + R \ \ kN\backslash m`$$

a = Distance Between Posts $= (2 \longrightarrow 3)\ m$

$$R_1 = w * a$$



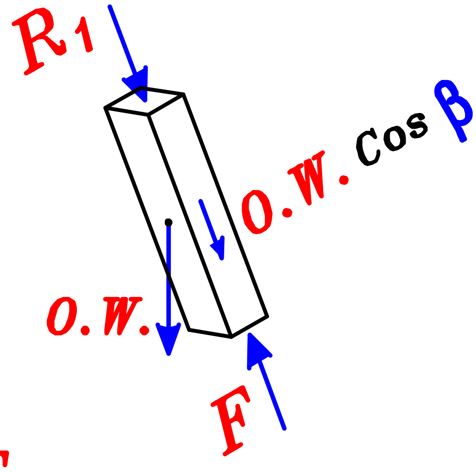
* Loads on the Post.

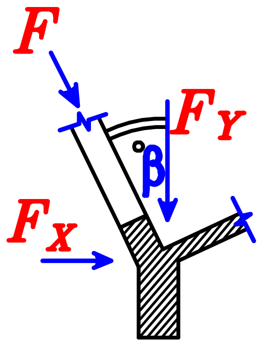
$$F = O.W._{(Post)} * \cos\beta + R_1$$

$$O.W._{(Post)} \simeq 3.50\ kN\ (U.L.)$$

$$F_Y = F \cos\beta$$

$$F_X = F \sin\beta$$



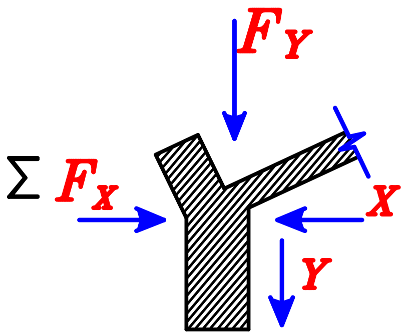


* Loads on Y-Beam.

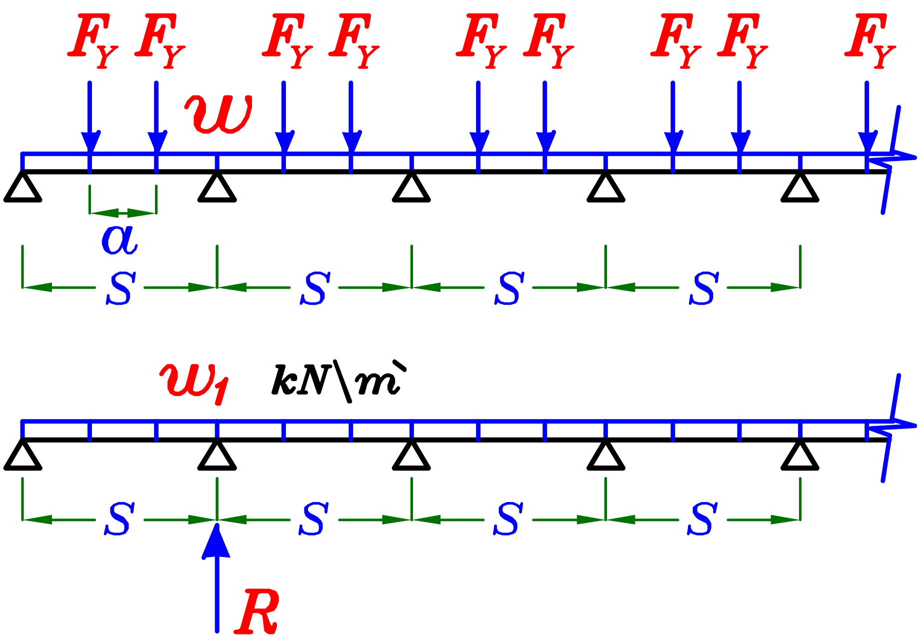
$\because\ X = \sum F_X\ (at\ one\ span) \qquad \therefore \sum x = Zero$

$$w = O.W._{(beam)} + Y = \checkmark\ kN\backslash m'$$

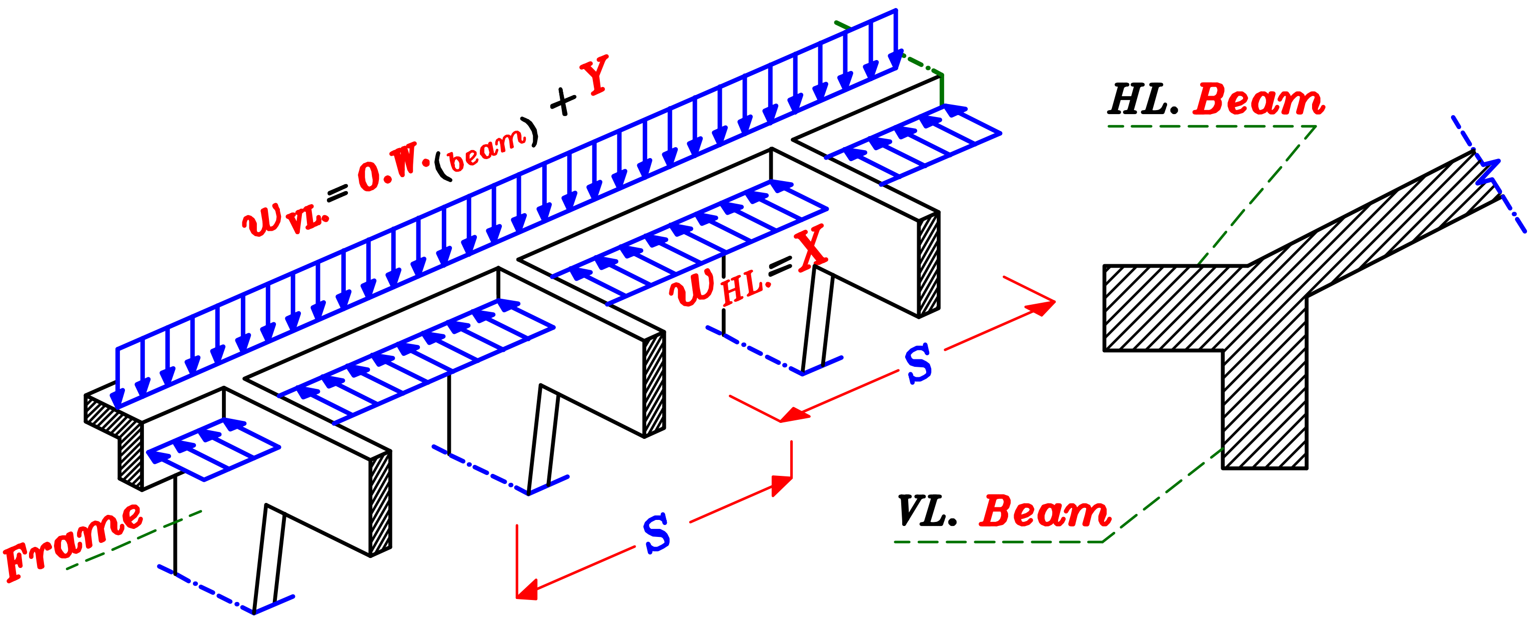
$$w_1 = w + \frac{\sum F_Y\ (at\ one\ span)}{Span}$$



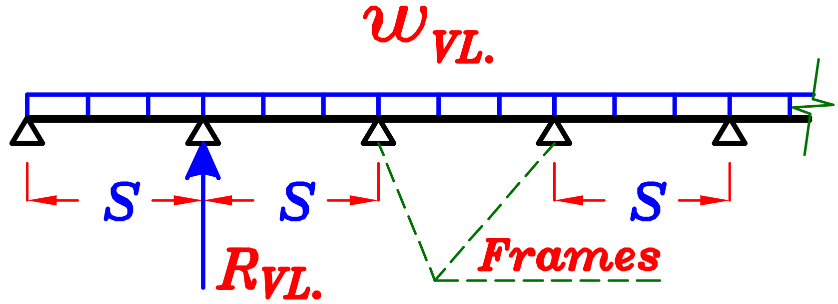
$$R = w_1 * S + F_Y$$



* Loads on End Beam.



VL. Beam.

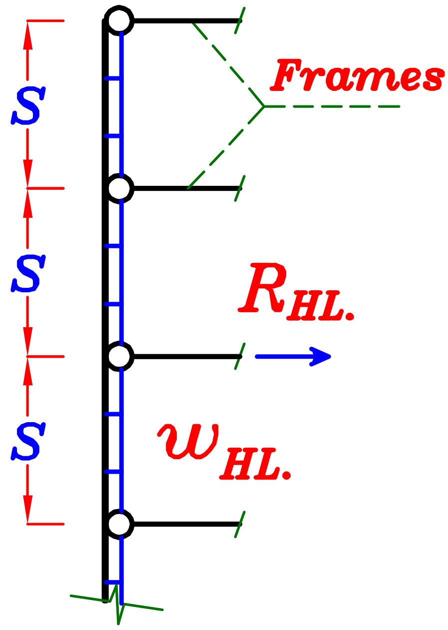


$$w_{VL.} = O.W._{(beam)} + Y \quad kN\backslash m`$$

$$\underset{(beam)}{O.W.} \; (VL.+HL.) \simeq 7.0 \; kN$$

$$R_{VL.} = w_{VL.} * S$$

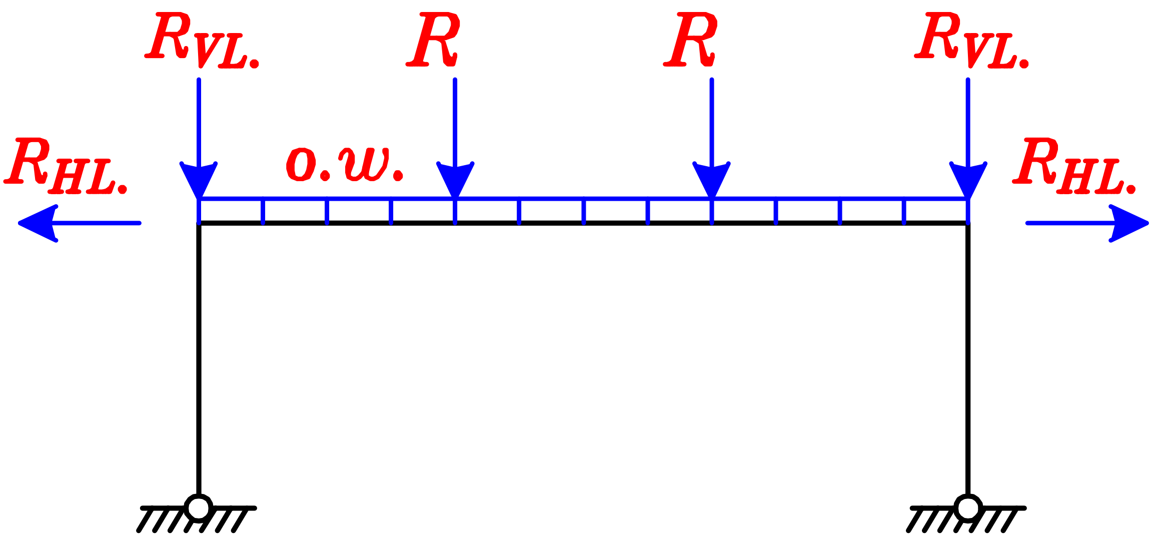
HL. Beam.

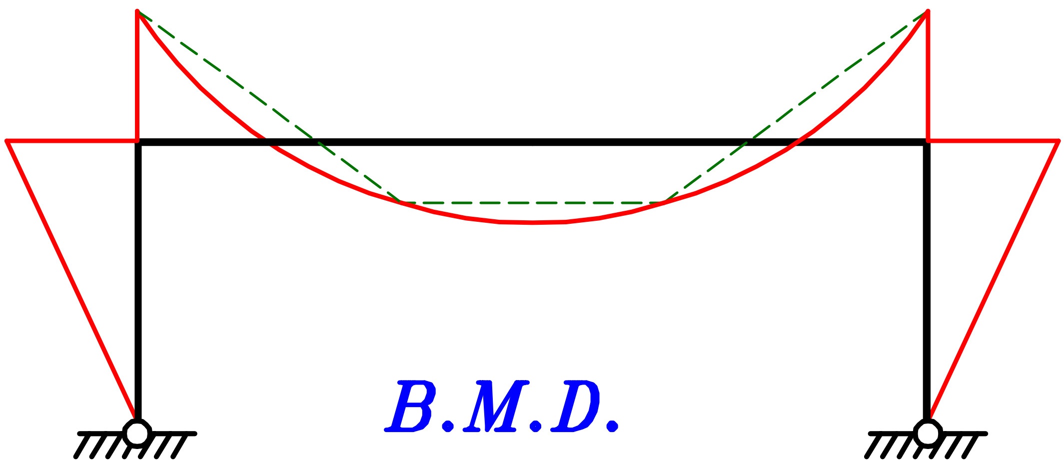


$$w_{HL.} = X \quad kN\backslash m`$$

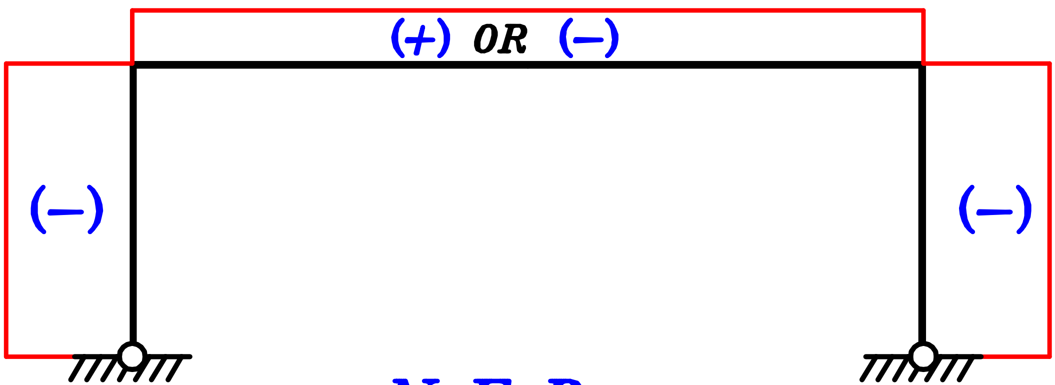
$$R_{HL.} = w_{HL.} * S$$

* Loads on The Frame.





B.M.D.

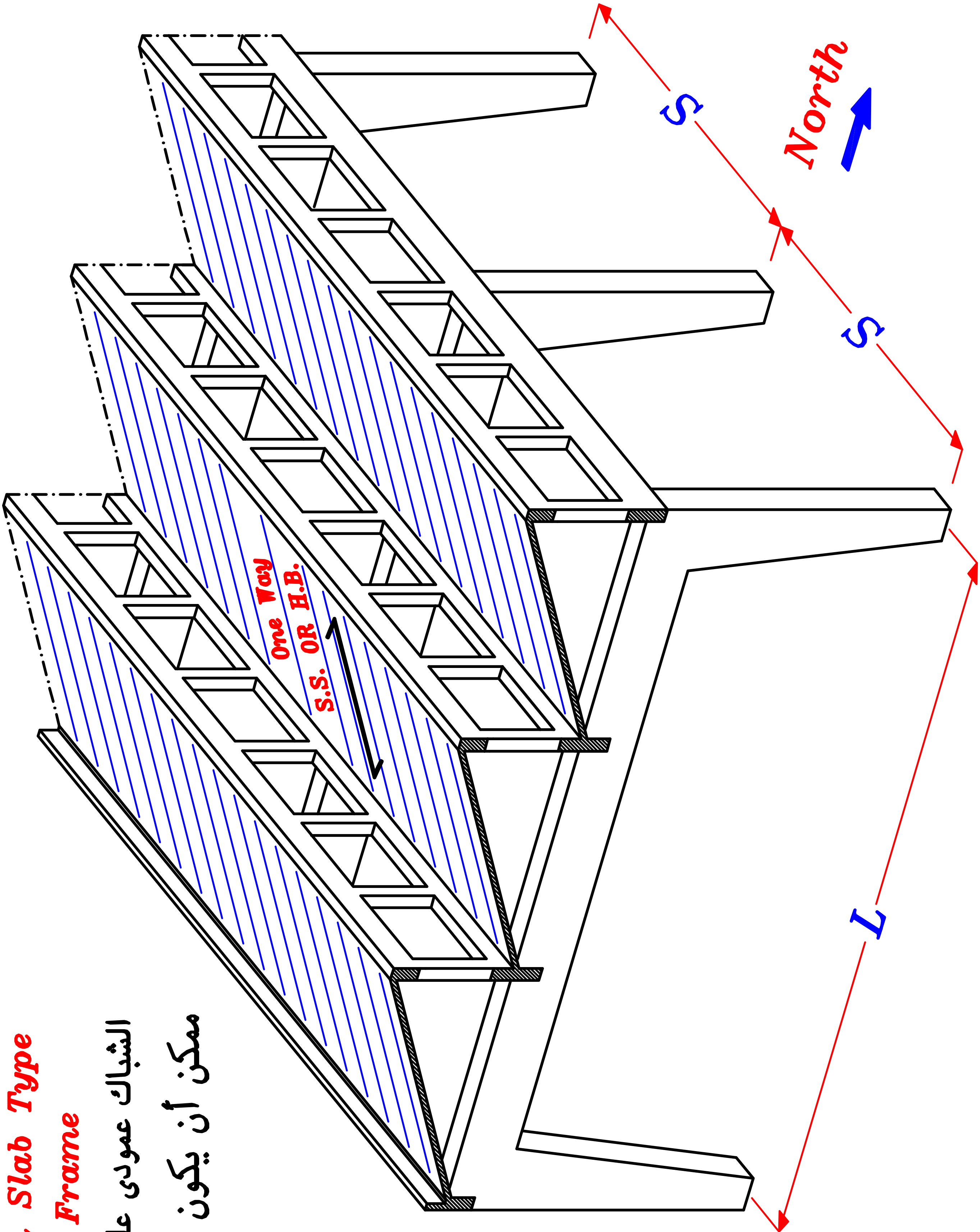


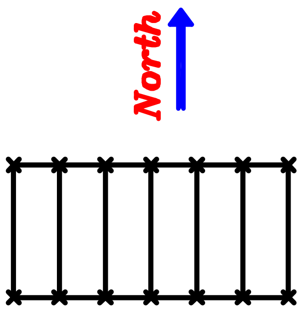
N.F.D.

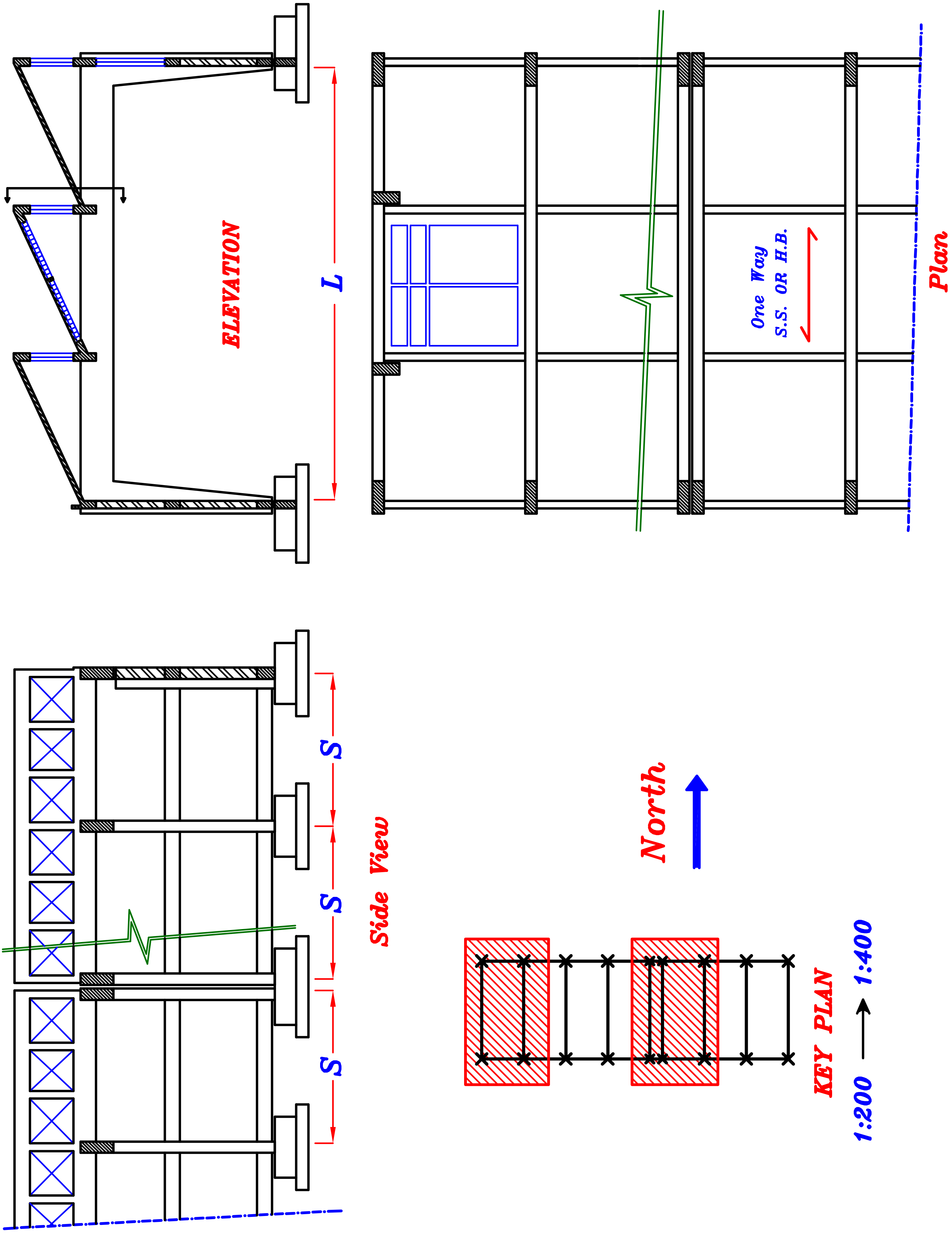
Saw Tooth Slab Type Rested on Frame

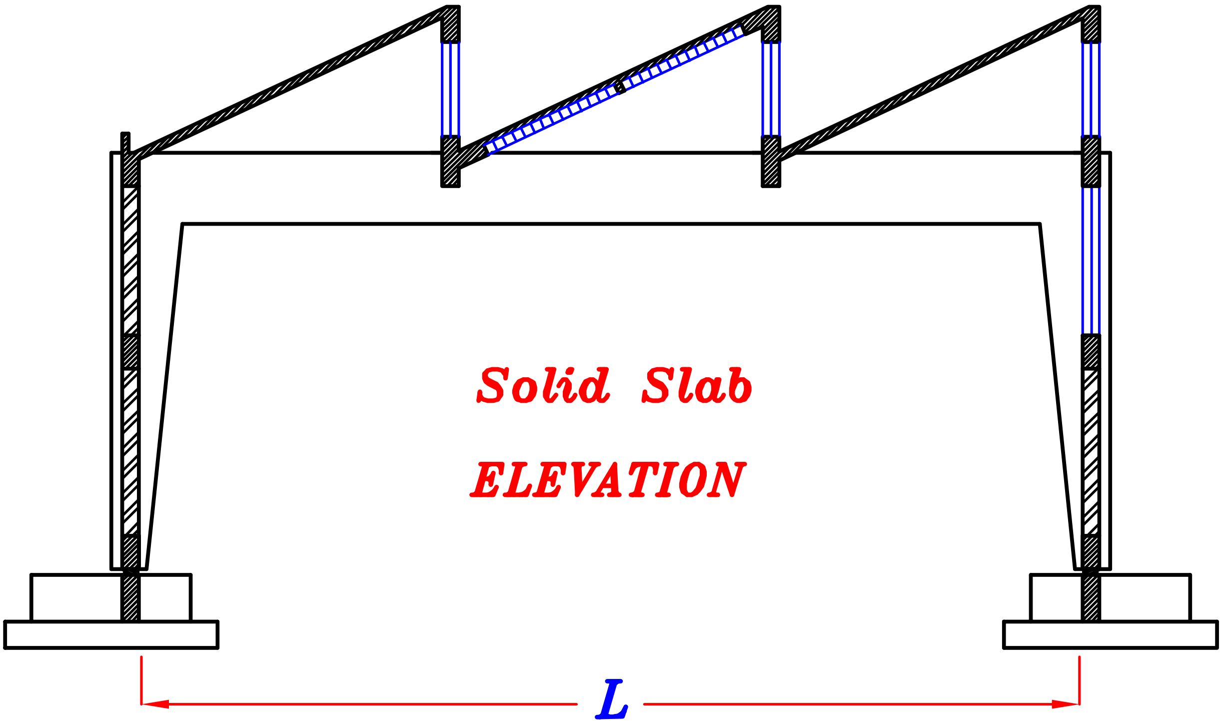
Frame الشباك عمودى على الـ

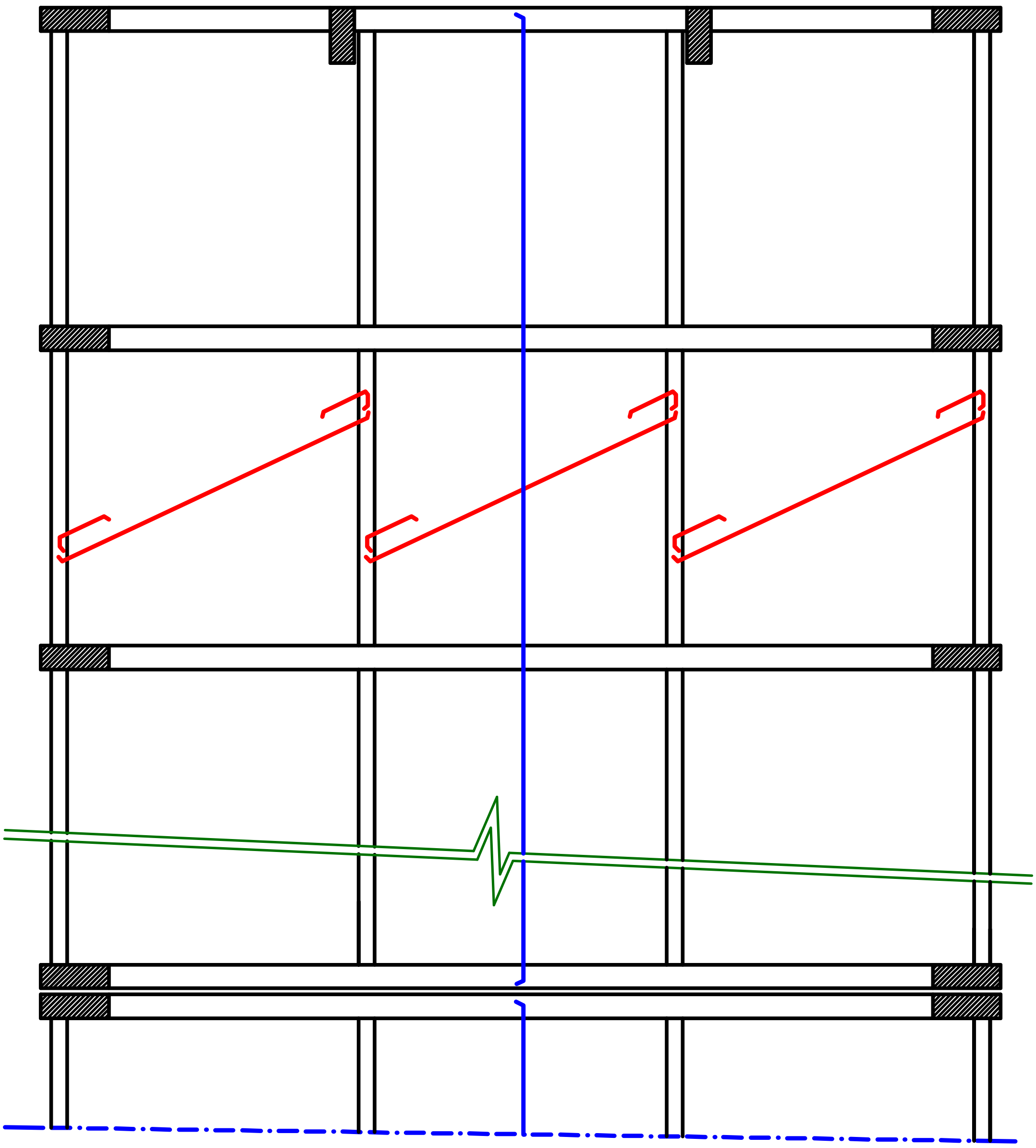
ممكن أن يكون الشباك رأسى



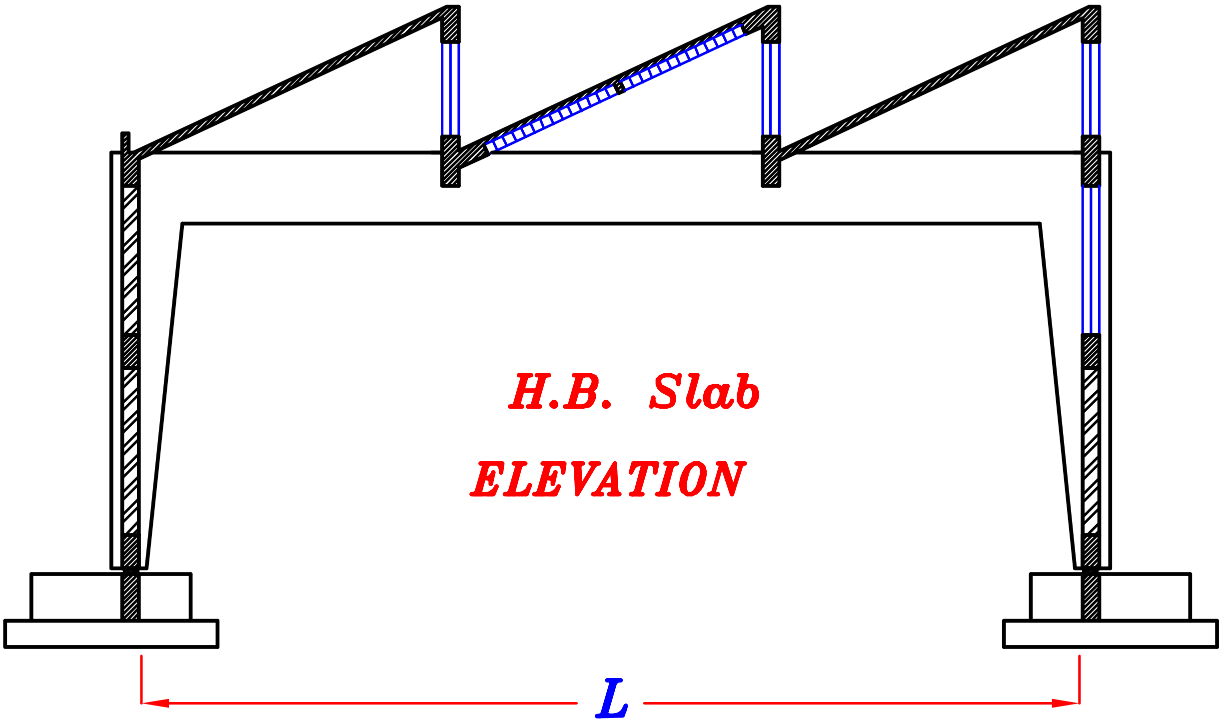


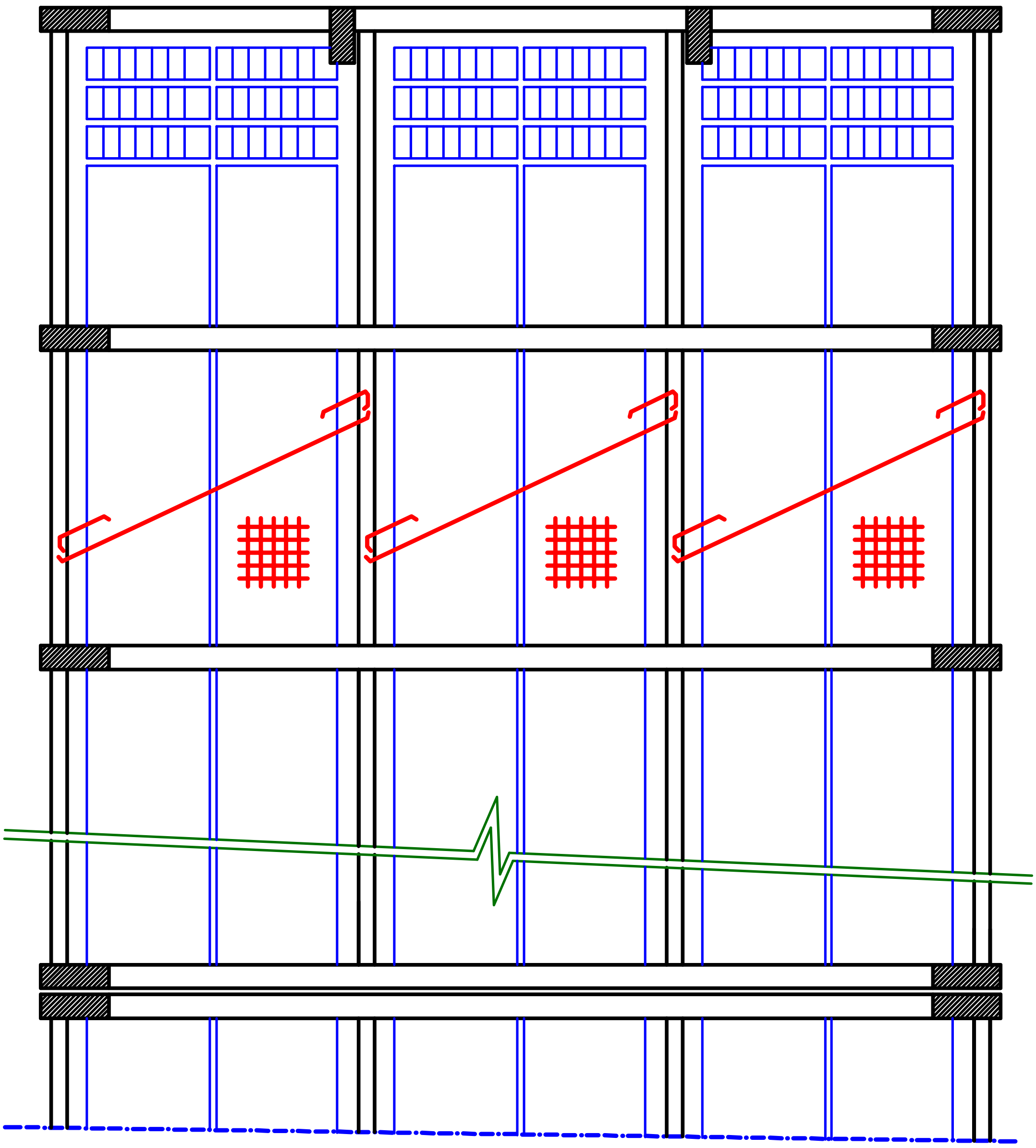

ELEVATION
L
One Way
S.S. OR H.B.
Plan
Side View
S
S
S
North
KEY PLAN
1:200 → 1:400





Plan





Plan

Steps of Design.

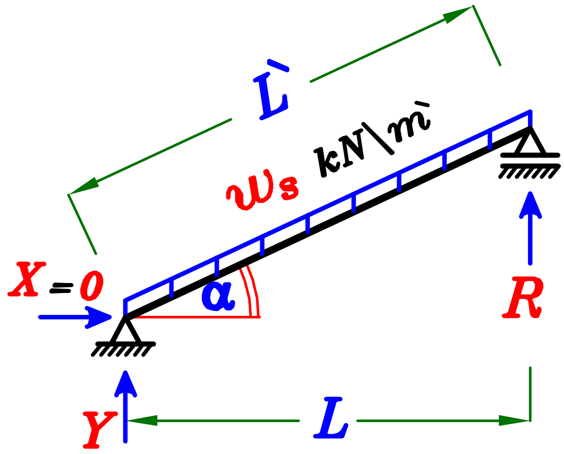
* Design the Slab.

Get w_s

then take a strip 1.0 m in the slab.

$$w_s = 1.4\,(t_s\,\gamma_c + F.C.) + 1.6\ L.L.\ \cos\alpha$$

$$M = \frac{w_s\,L\,L'}{8} \quad , \quad R = Y = \frac{w_s\,L'}{2}$$



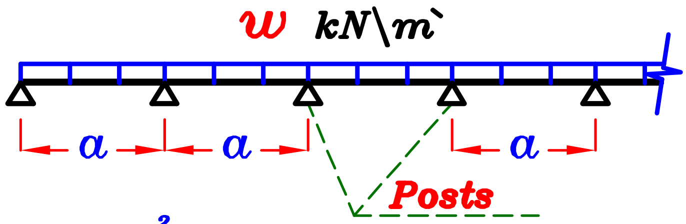
* Design the Ridge Beam.

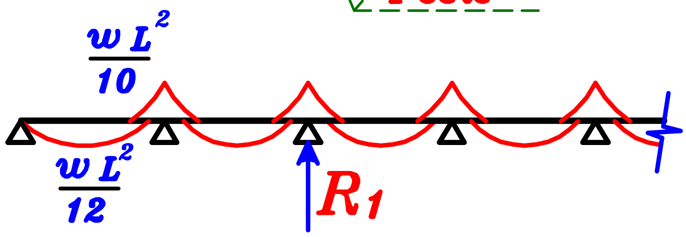
$$w = O.W._{(beam)} + R \qquad kN\backslash m'$$

α = Distance Between Posts

$= (2 \longrightarrow 3)$ m

$$R_1 = w * \alpha$$



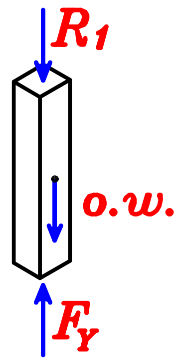


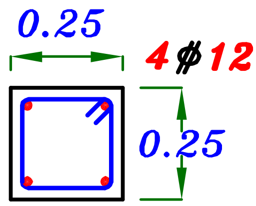
* Design the Post.

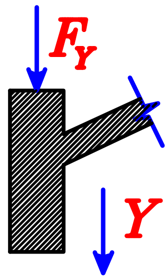
$$F_Y = O.W._{(Post)} + R_1$$

$$O.W._{(Post)} \simeq 3.50\ kN\ (U.L.)$$

$$P_{U.L.} = F_Y = 0.35\,A_c\,F_{cu} + 0.67\,A_s\,F_y$$







* Design of the Y–Beam.

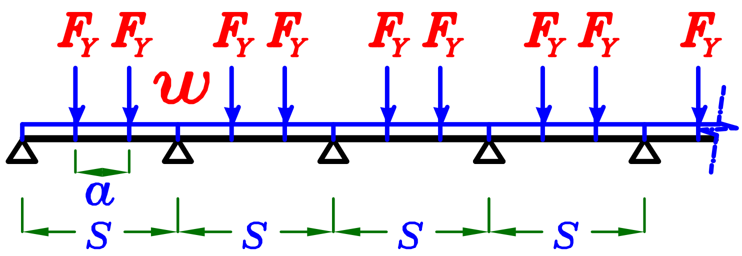
$$w = O.W._{(beam)} + Y = \checkmark\ kN\backslash m'$$

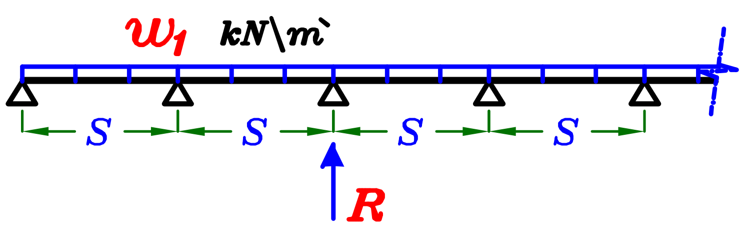
Solved by using Moment Dist.

or use Approximate Solution.

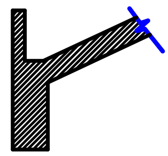
$$w_1 = w + \frac{\sum F_Y\,(\text{at one span})}{Span}$$

$$R = w_1 * S + F_Y$$



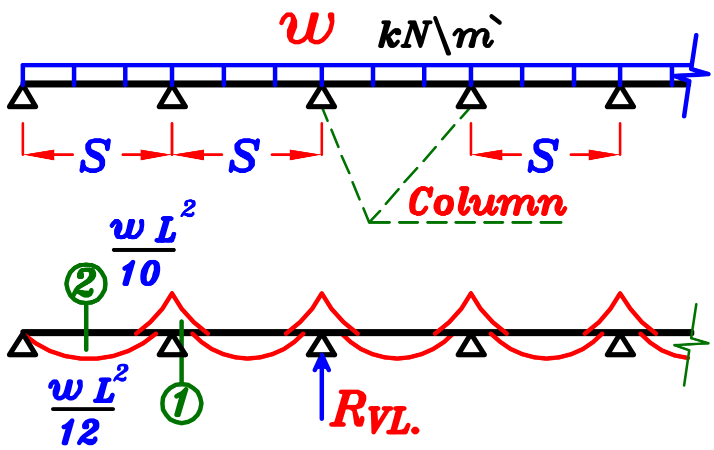


* Design of End Beam. B_1



$w = O.W._{(beam)} + Y \quad kN\backslash m'$

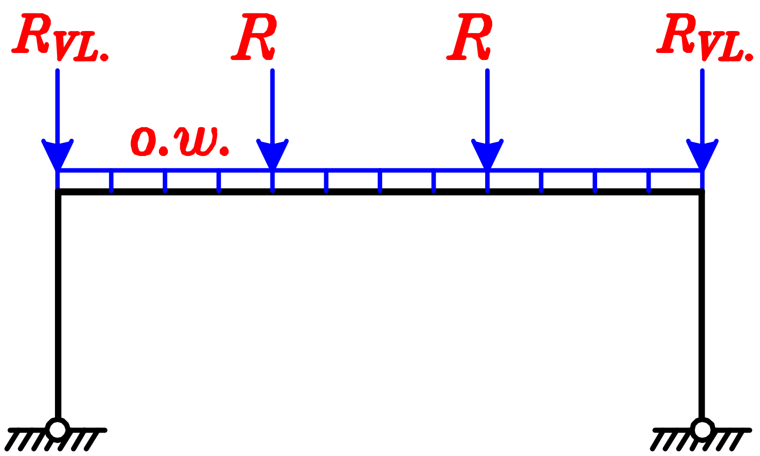
$O.W._{(beam)} \simeq 4.20 \; kN \; (U.L.)$

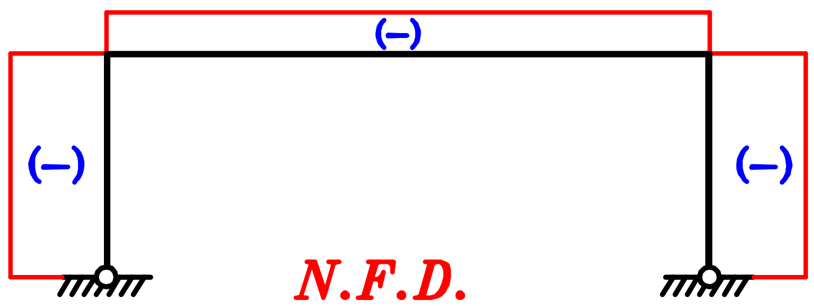


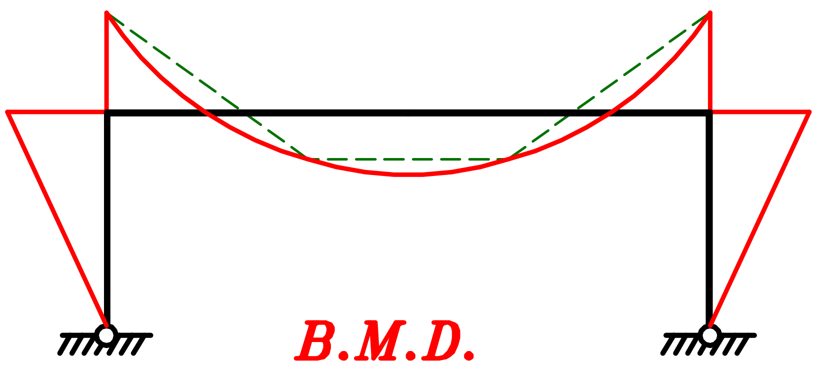
Designed as R-Sec.

$R_{VL.} = w_{VL.} * S$

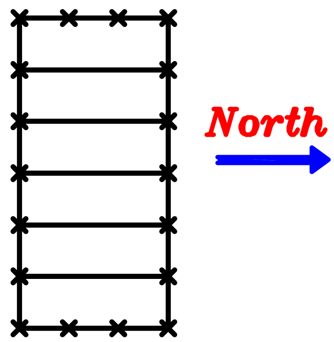
* Loads on The Frame.

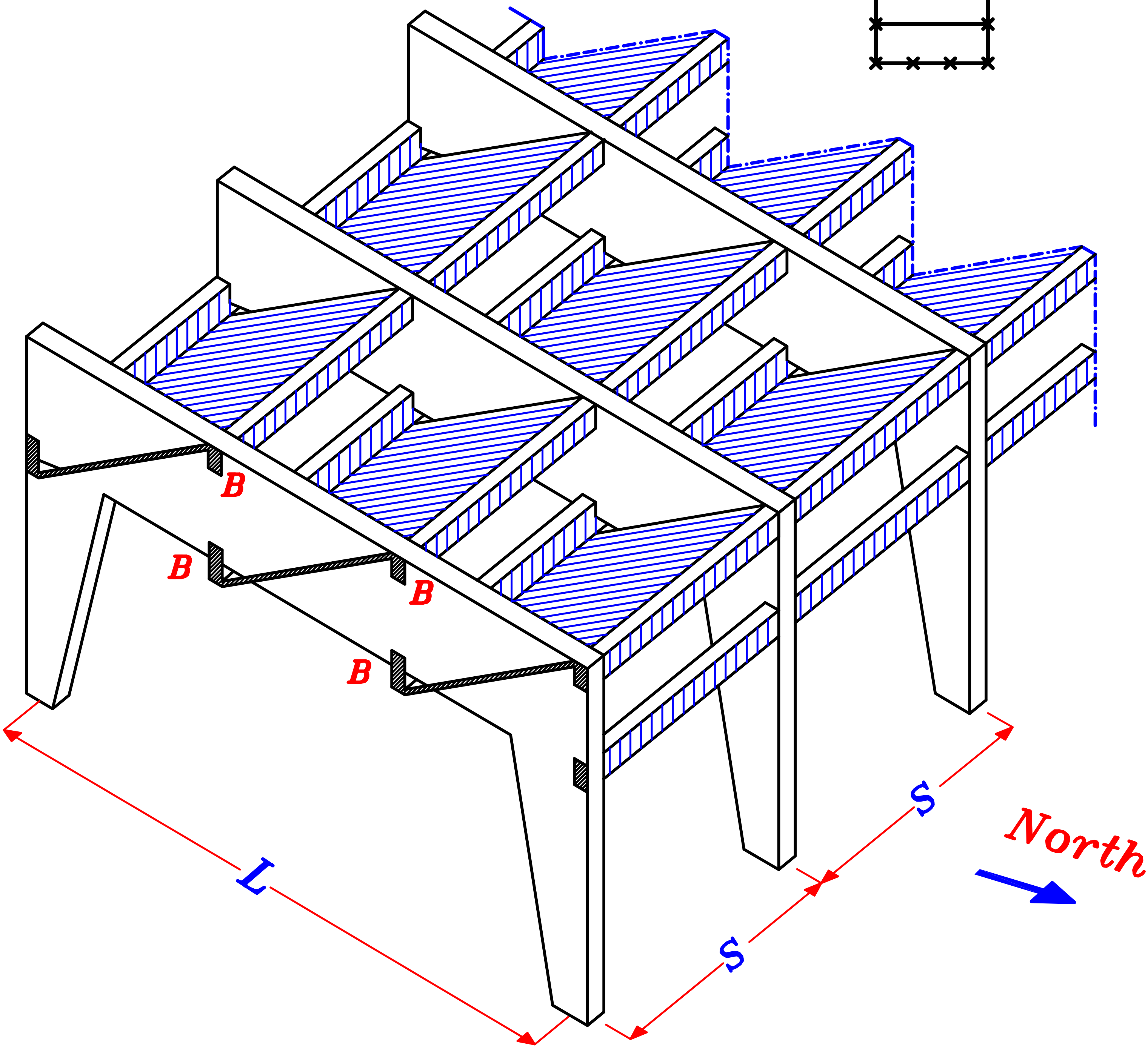


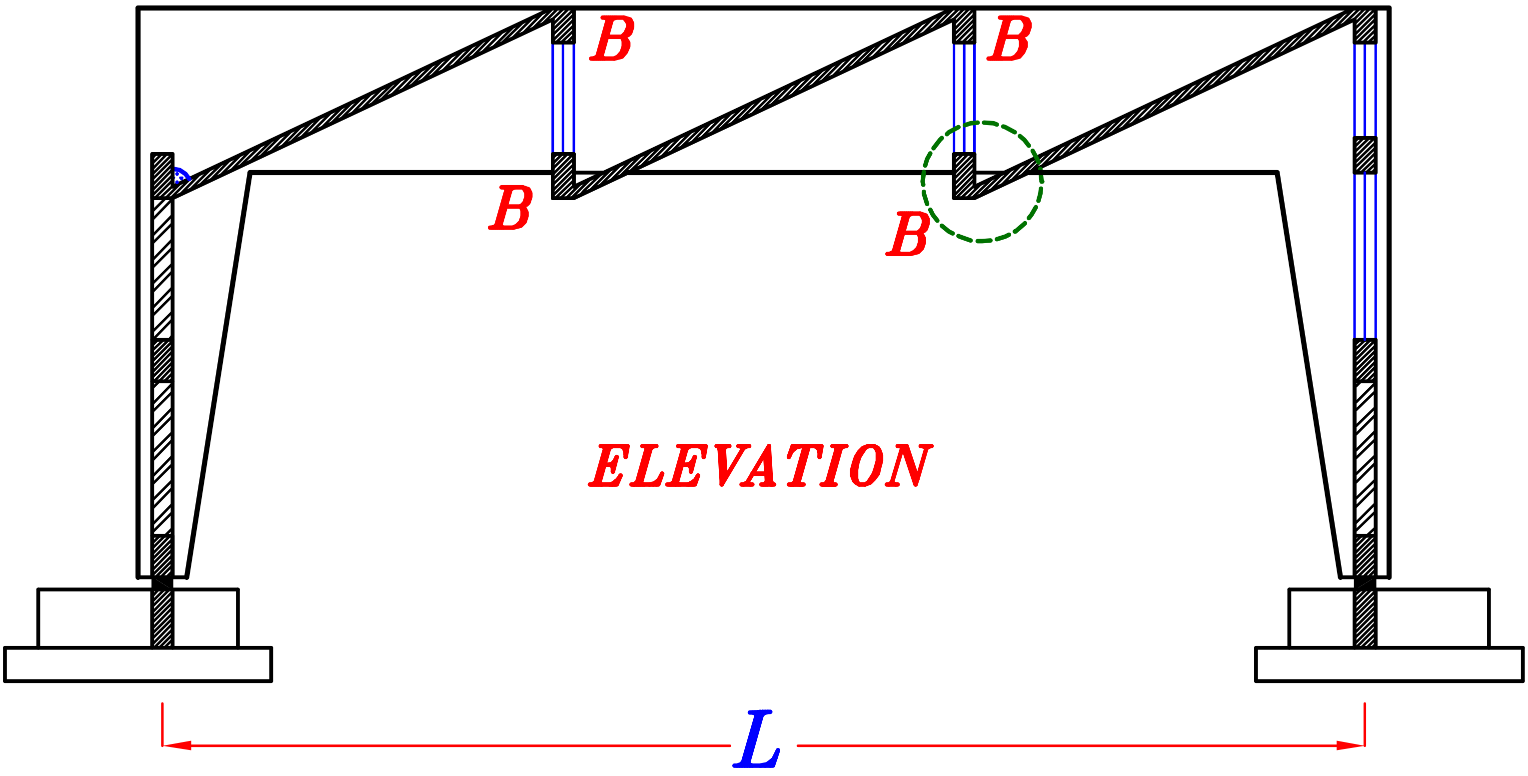


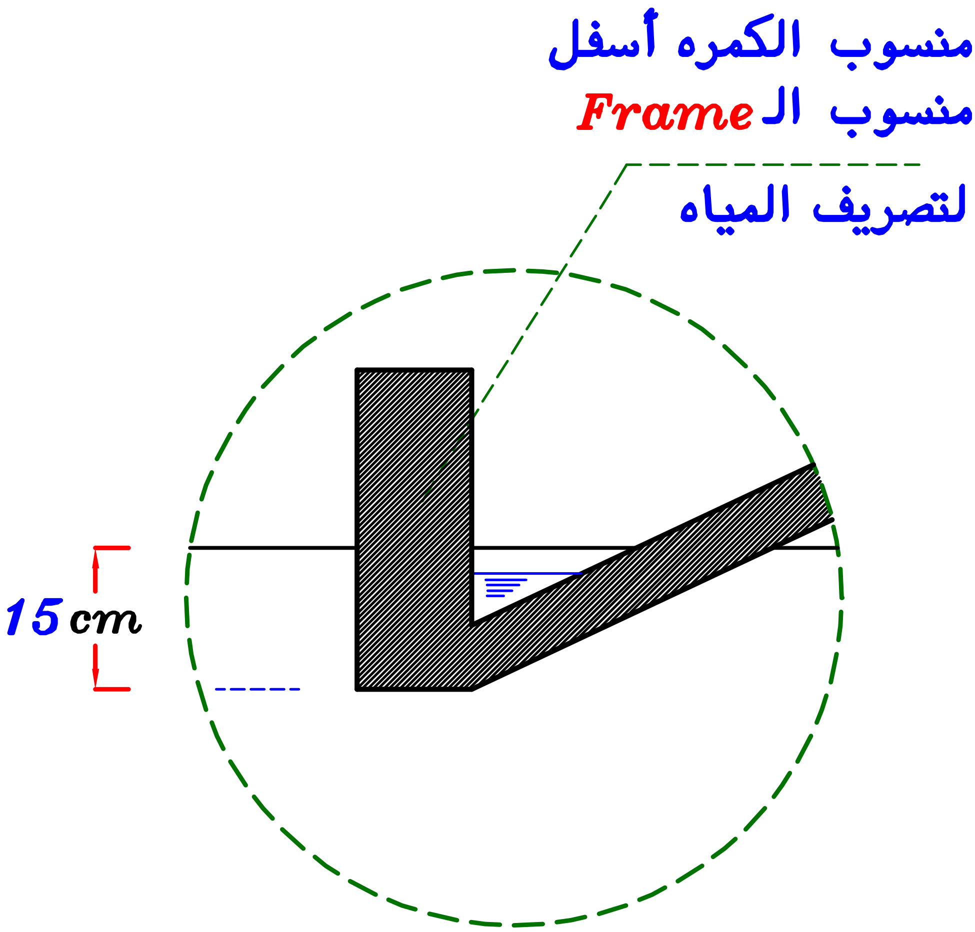


Saw Tooth Slab
Rested on Frame
Frame منسوب الشباك داخل ال
Frame الشباك عمودى على ال





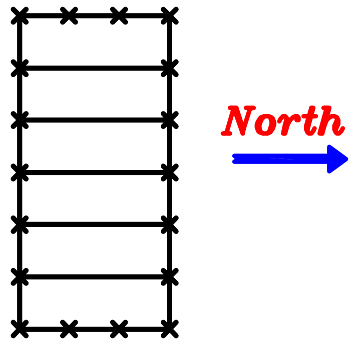

B
B
B
B
ELEVATION
L

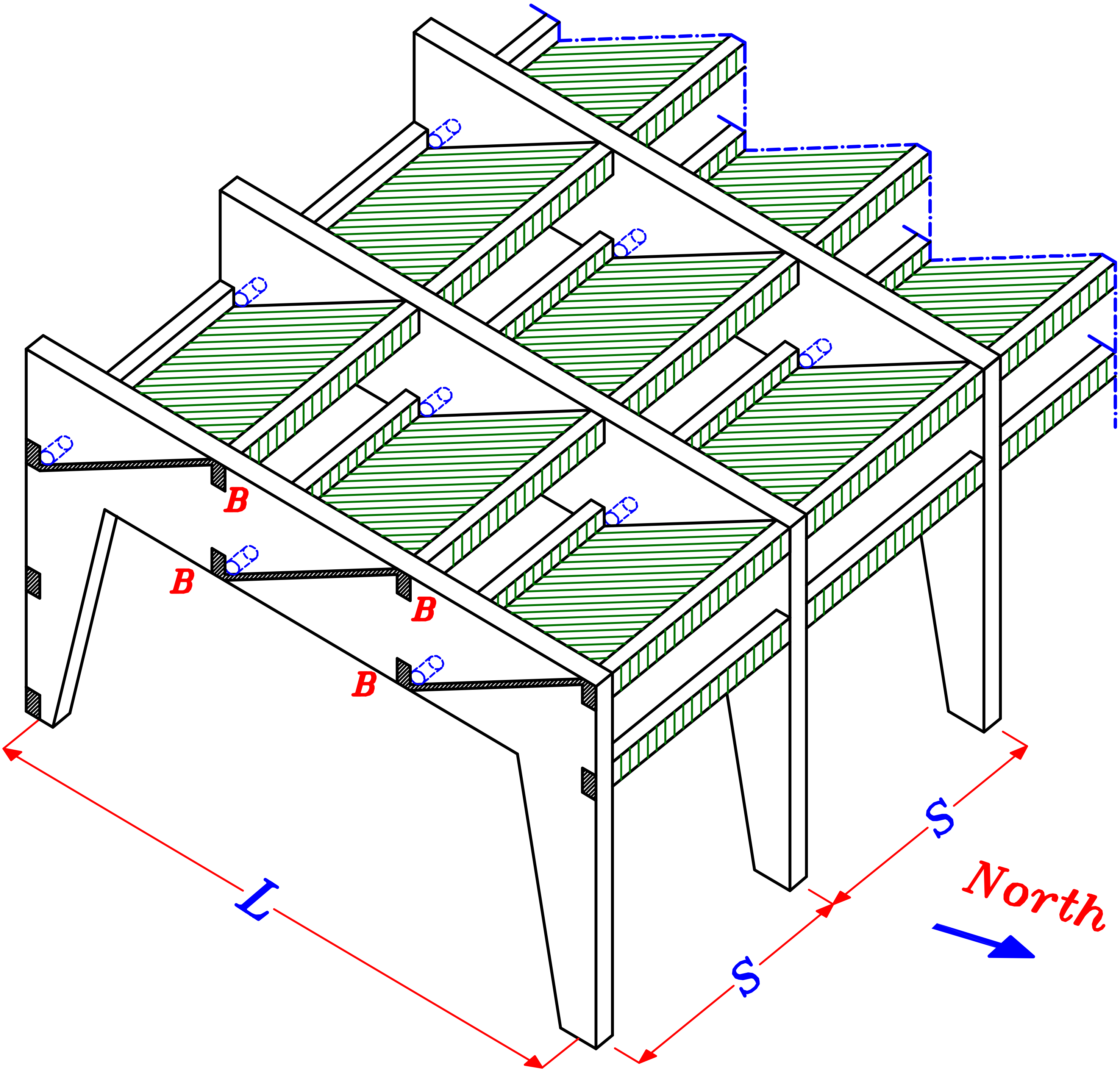

منسوب الكمره أسفل
منسوب الـ Frame
لتصريف المياه
15 cm

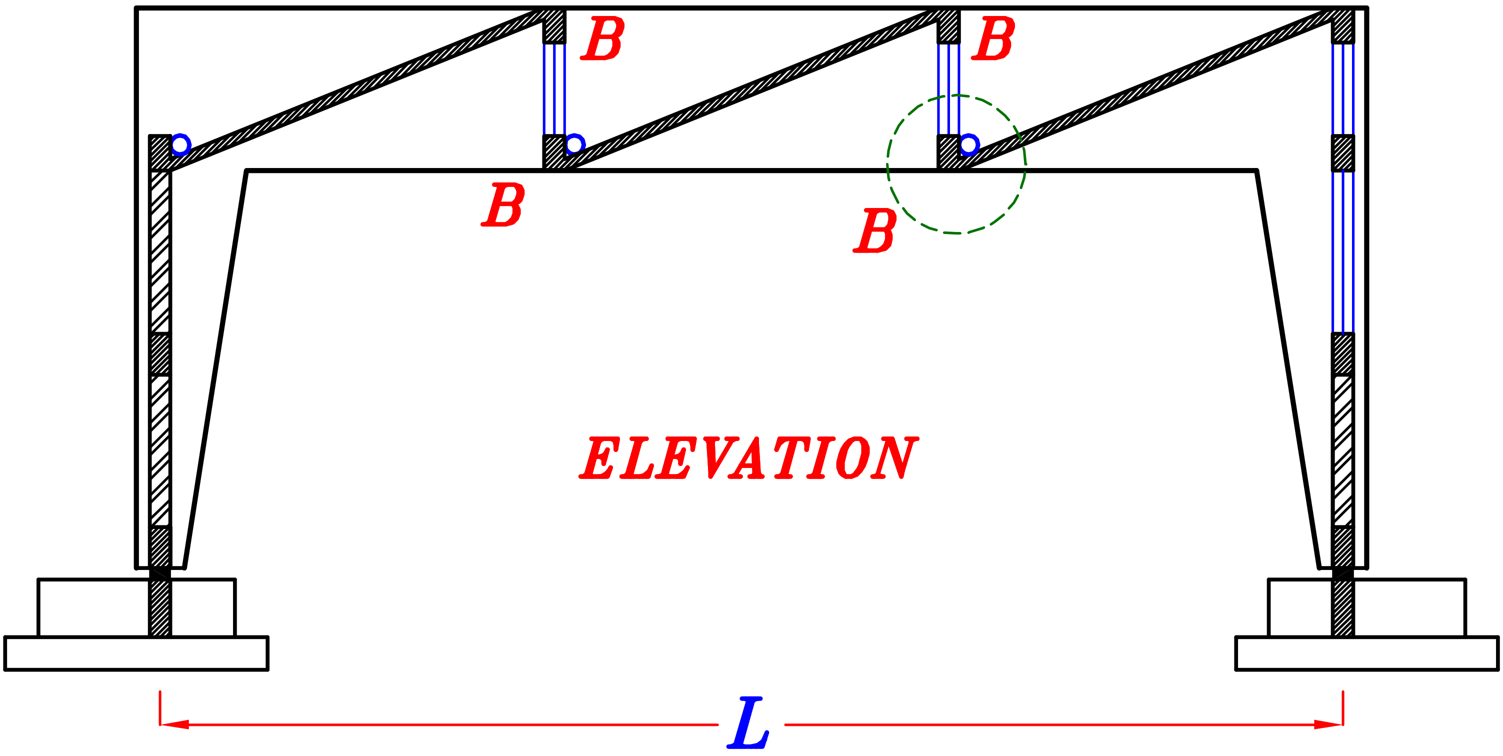
Saw Tooth Slab
Rested on Frame

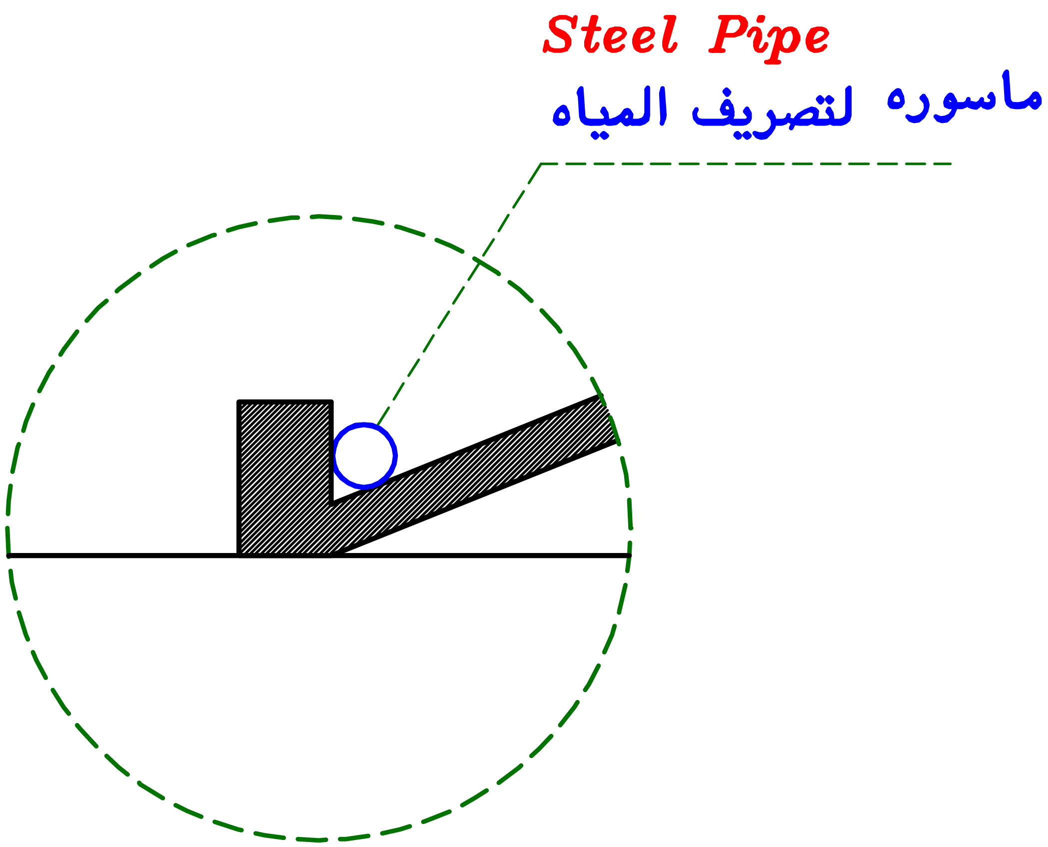
منسوب الشباك داخل ال Frame

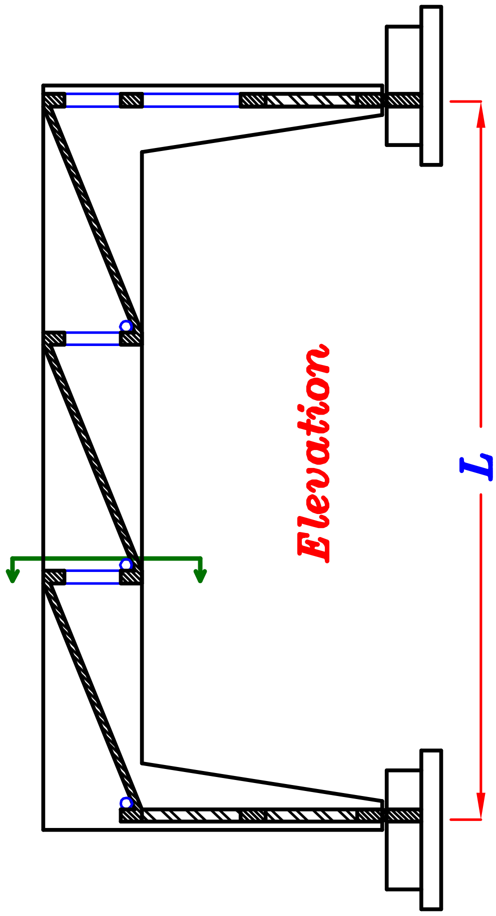
الشباك عمودى على ال Frame

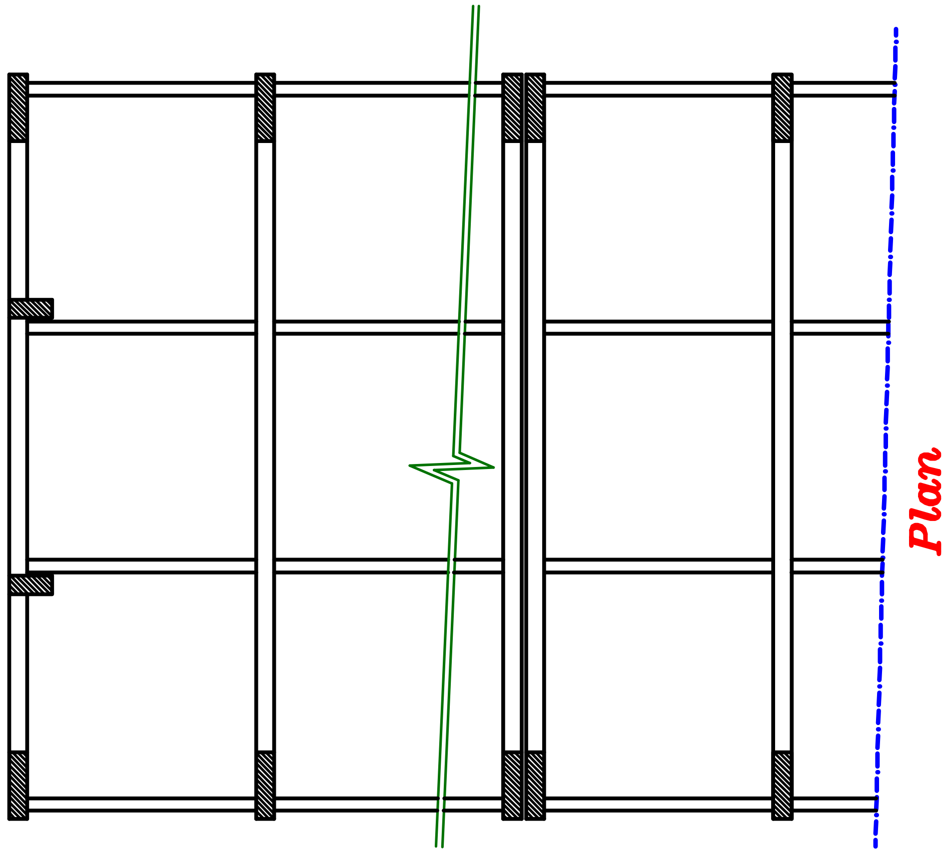


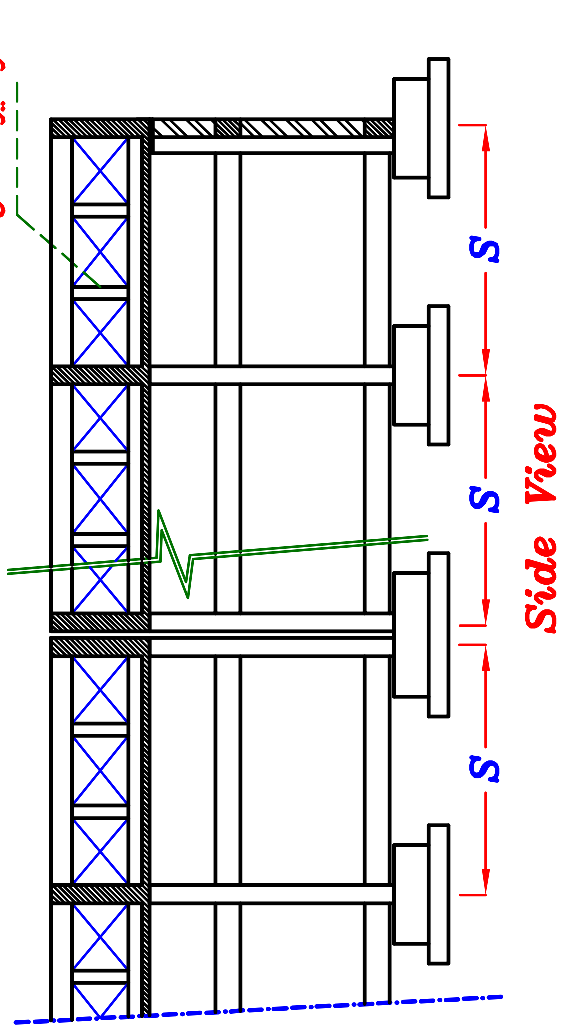


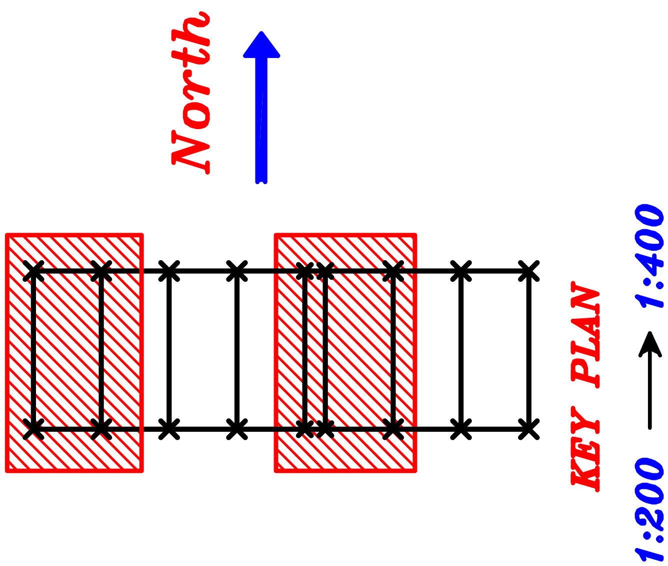

B
B
B
B
ELEVATION
L

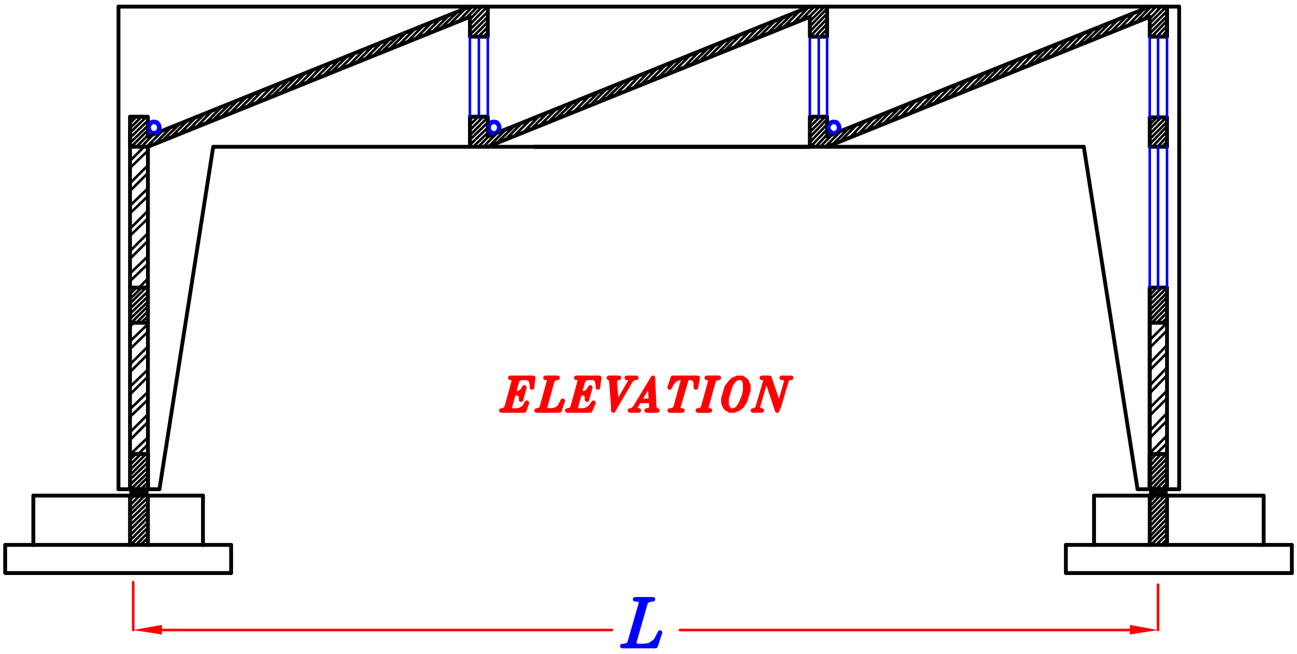

Steel Pipe
ماسوره لتصريف المياه

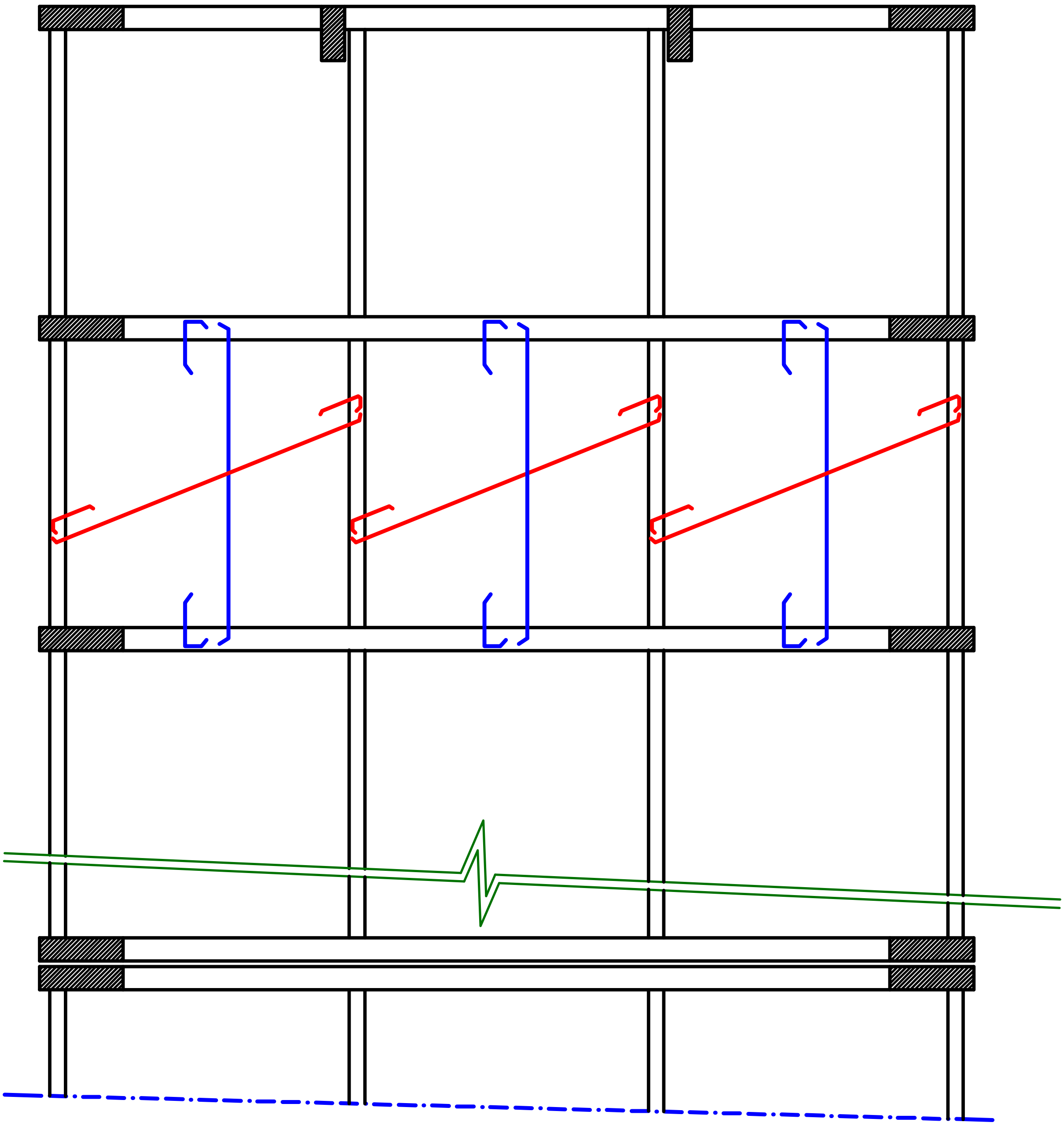

Elevation
L


Plan

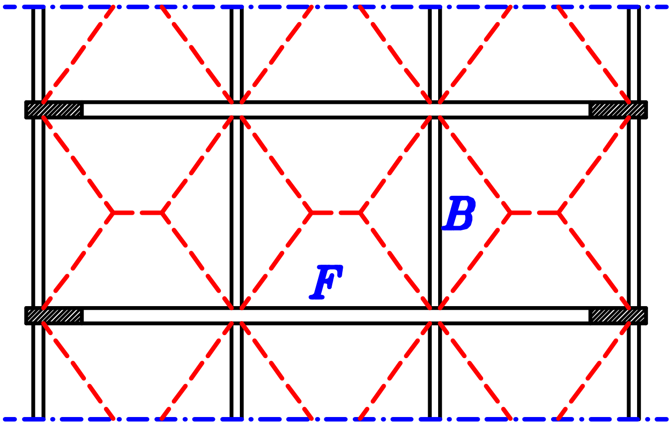

عنصر غير انشائى
S
S
S
Side View

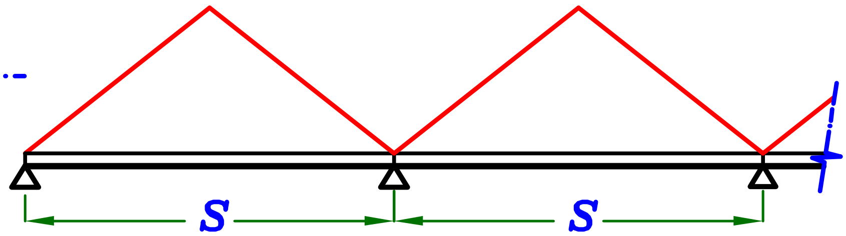

North
KEY PLAN
1:200 → 1:400



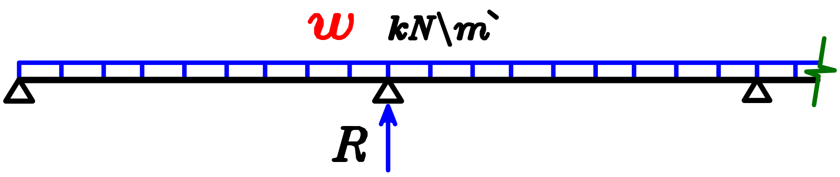


Plan





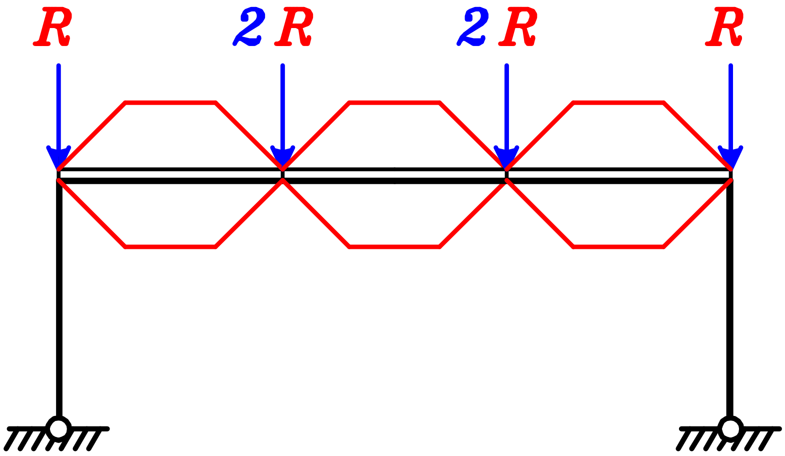
* **Loads on Beam B**



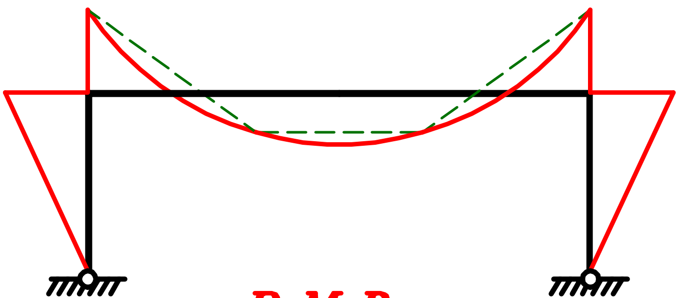
$$w = o.w. + C_a \, w_s \, \frac{L_s}{2} = \checkmark \ kN\backslash m`$$

$$R = w * S$$

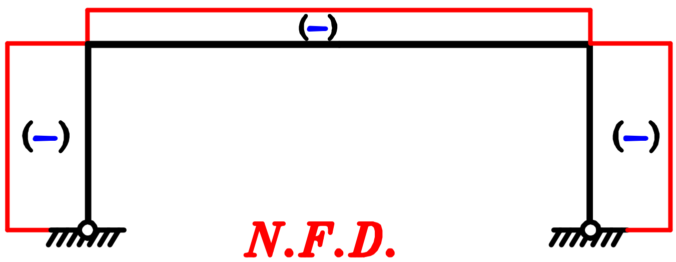
* **Loads on The Frame.**



$$w = o.w. + \frac{\overset{6}{\sum} area}{L} * w_s = \checkmark \ kN\backslash m`$$

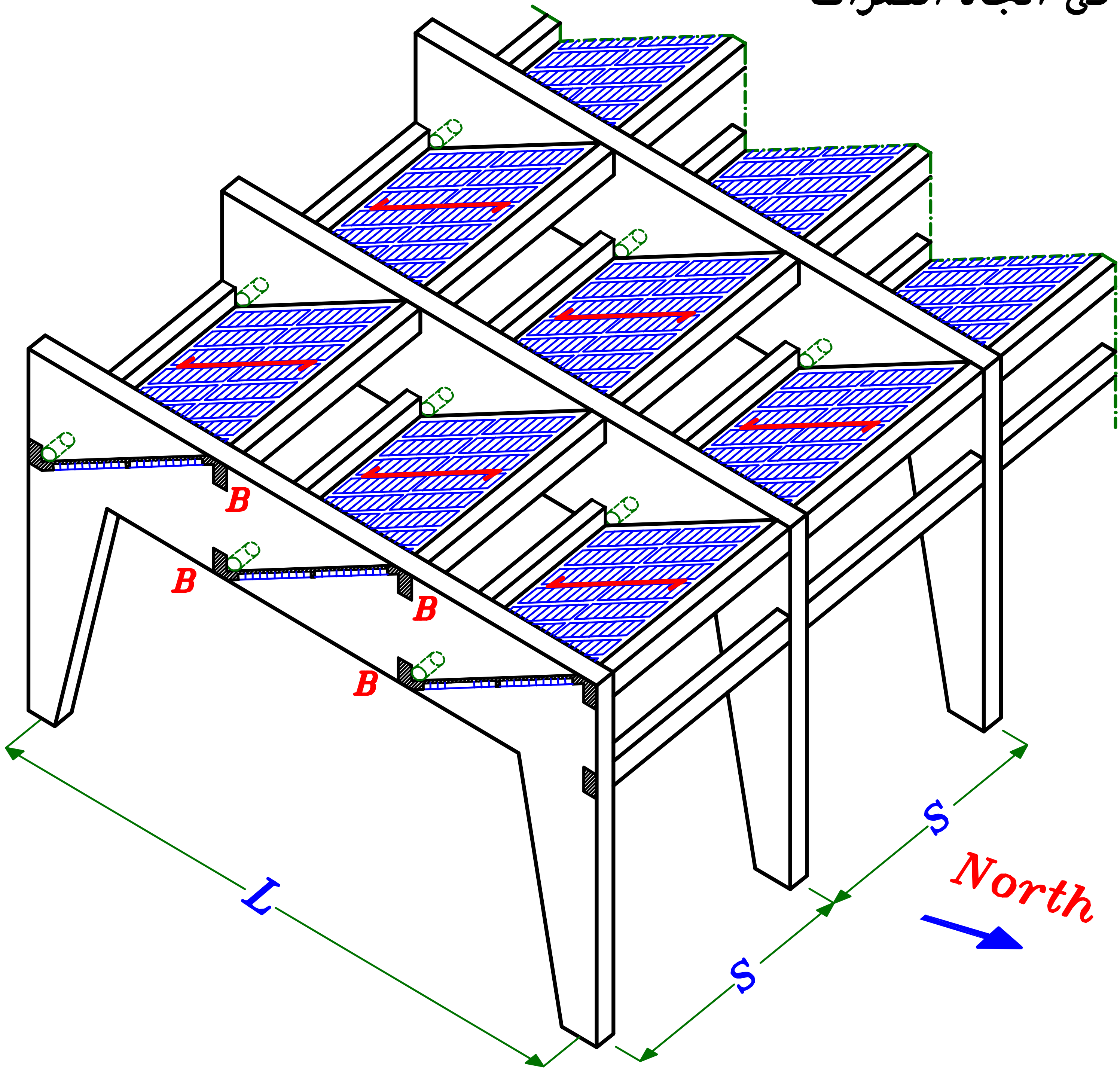


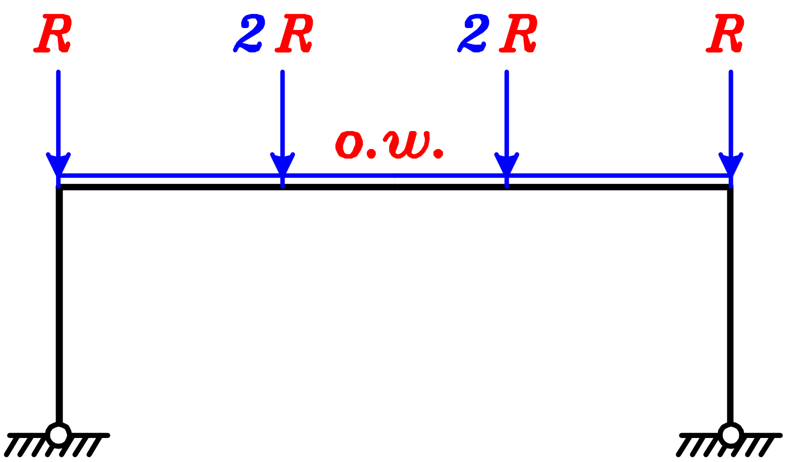
B.M.D.

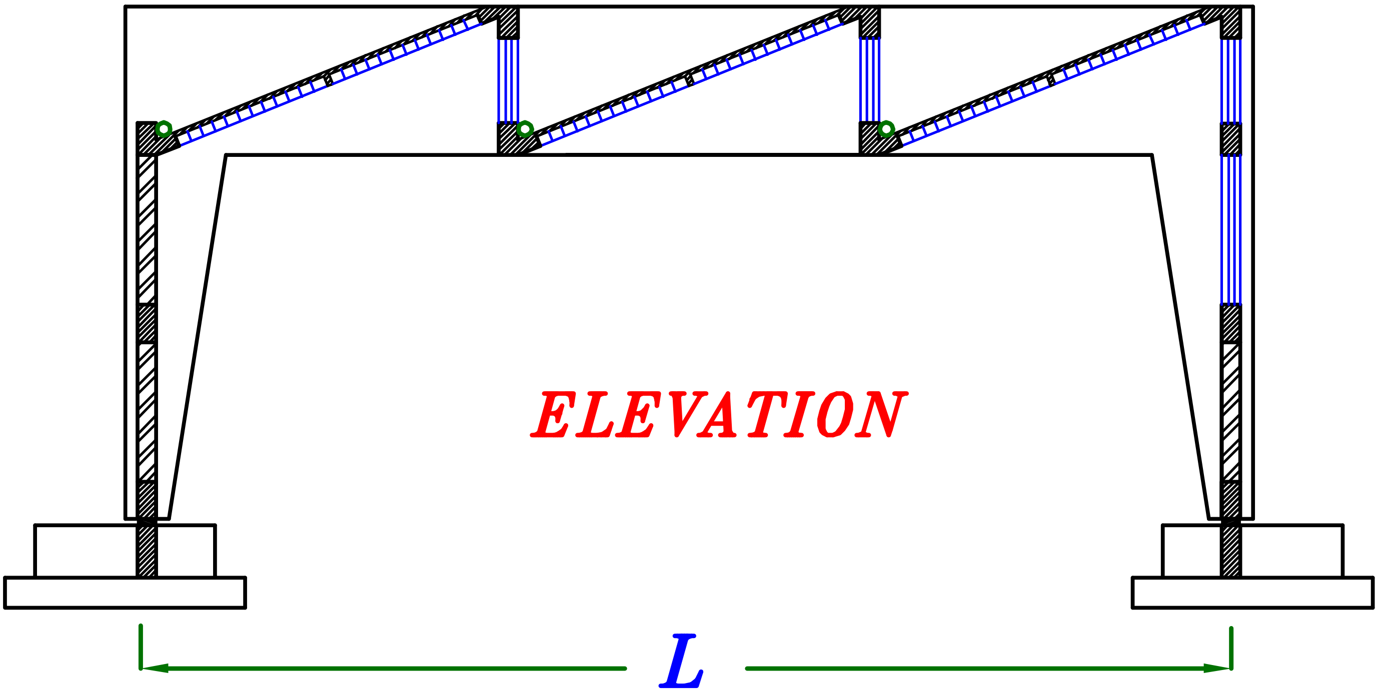


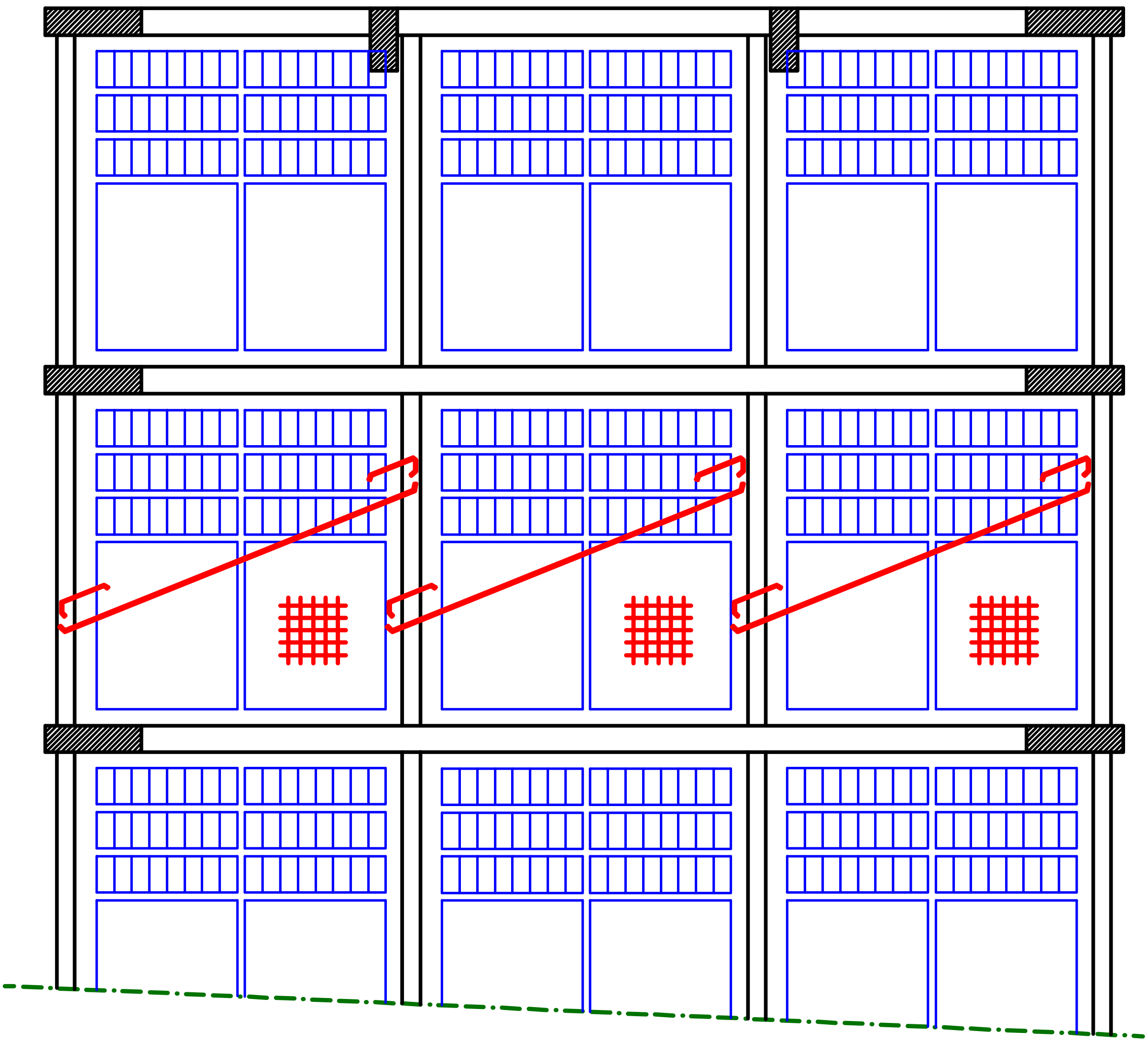
N.F.D.

الاسهل فى الحسابات ان نأخذ البلاطه *One way H.B.*
فى اتجاه الكمرات .

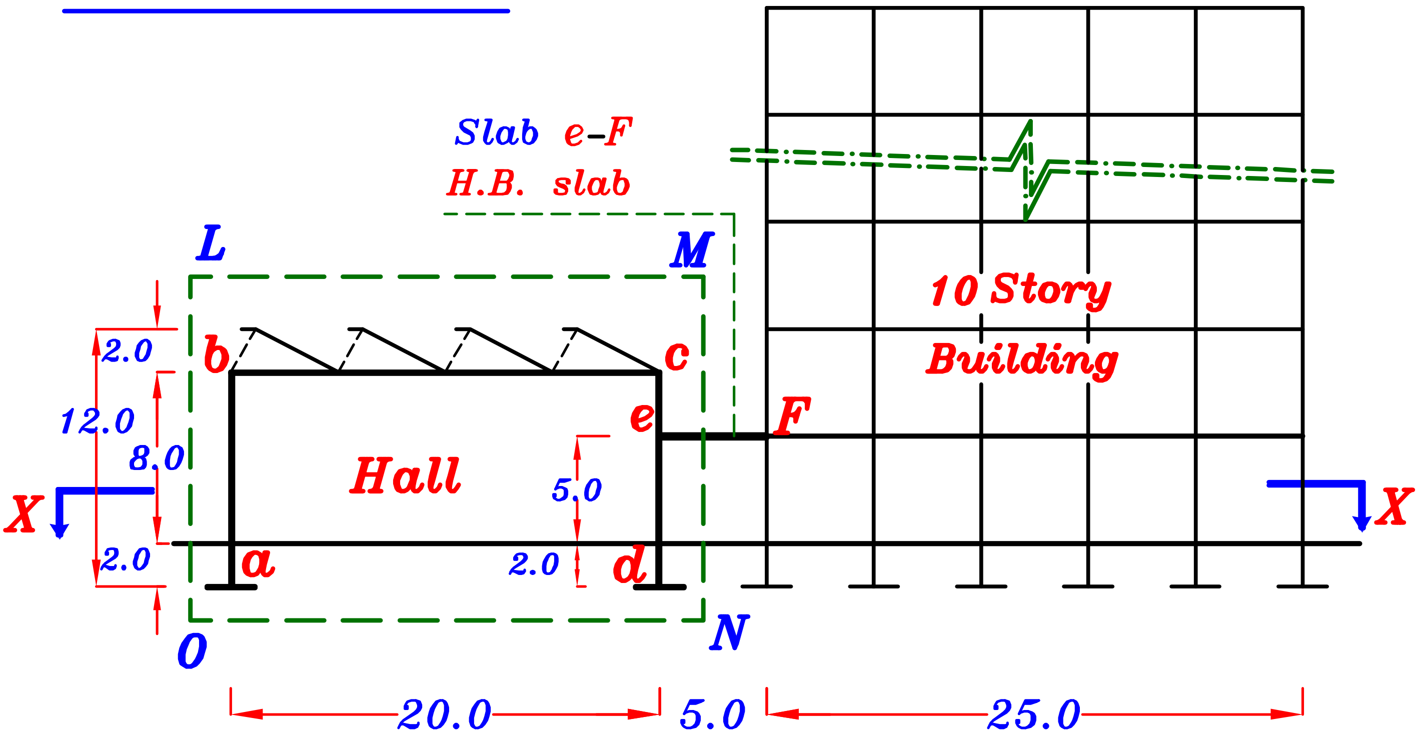




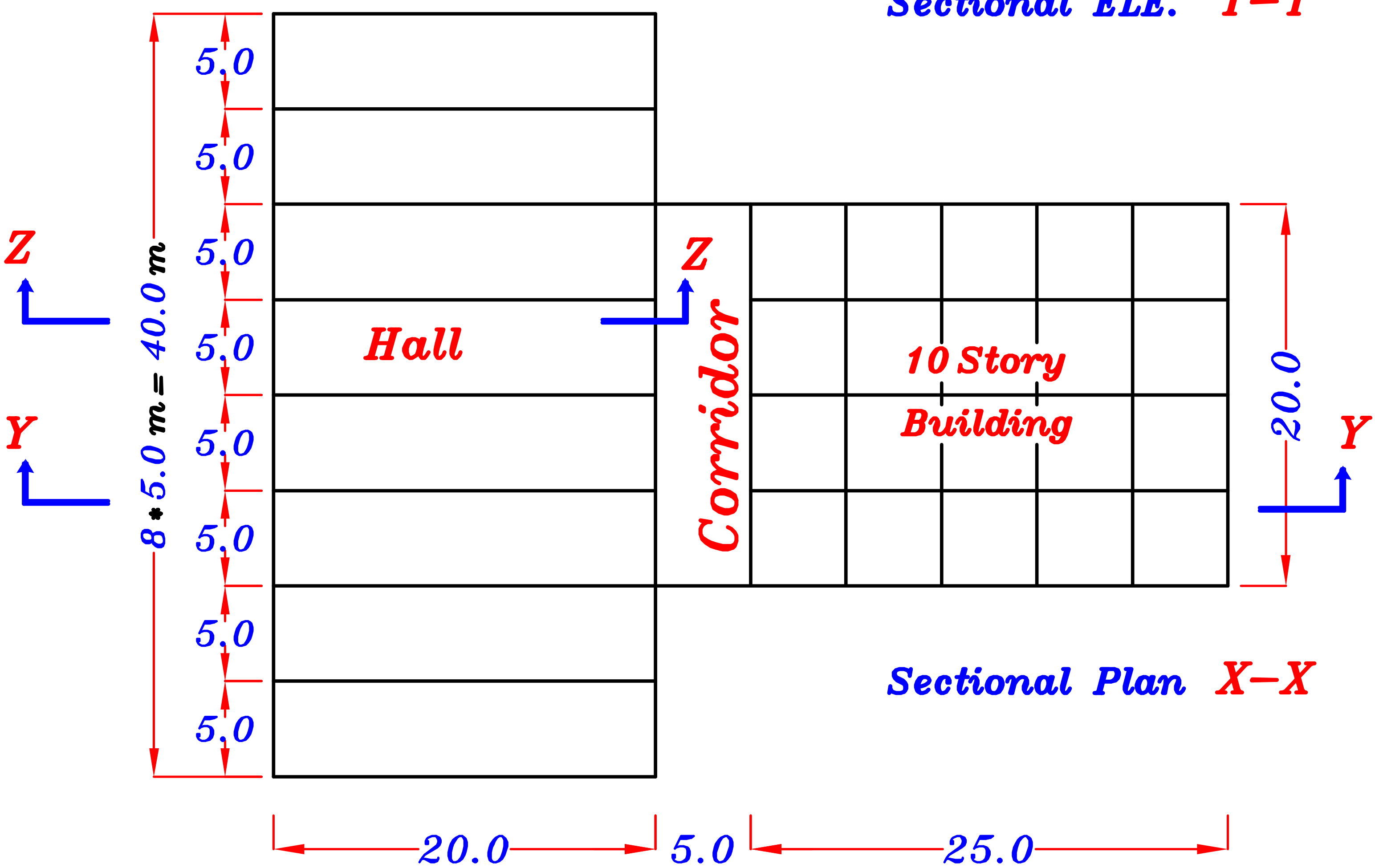

ELEVATION
L


PLAN

Example.



Sectional ELE. Y–Y



Sectional Plan X–X

The given sec. plan X–X & Elevation Y–Y show the General layout of ten story building (25*20 m)
which is attached to a hall (20*40 m) through a corridor.
The spacing between the main elements of the hall is 5.0 m
Columns and 25 cm brick walls are placed along the perimeter of the hall is of the Saw Tooth type.

Design Data :

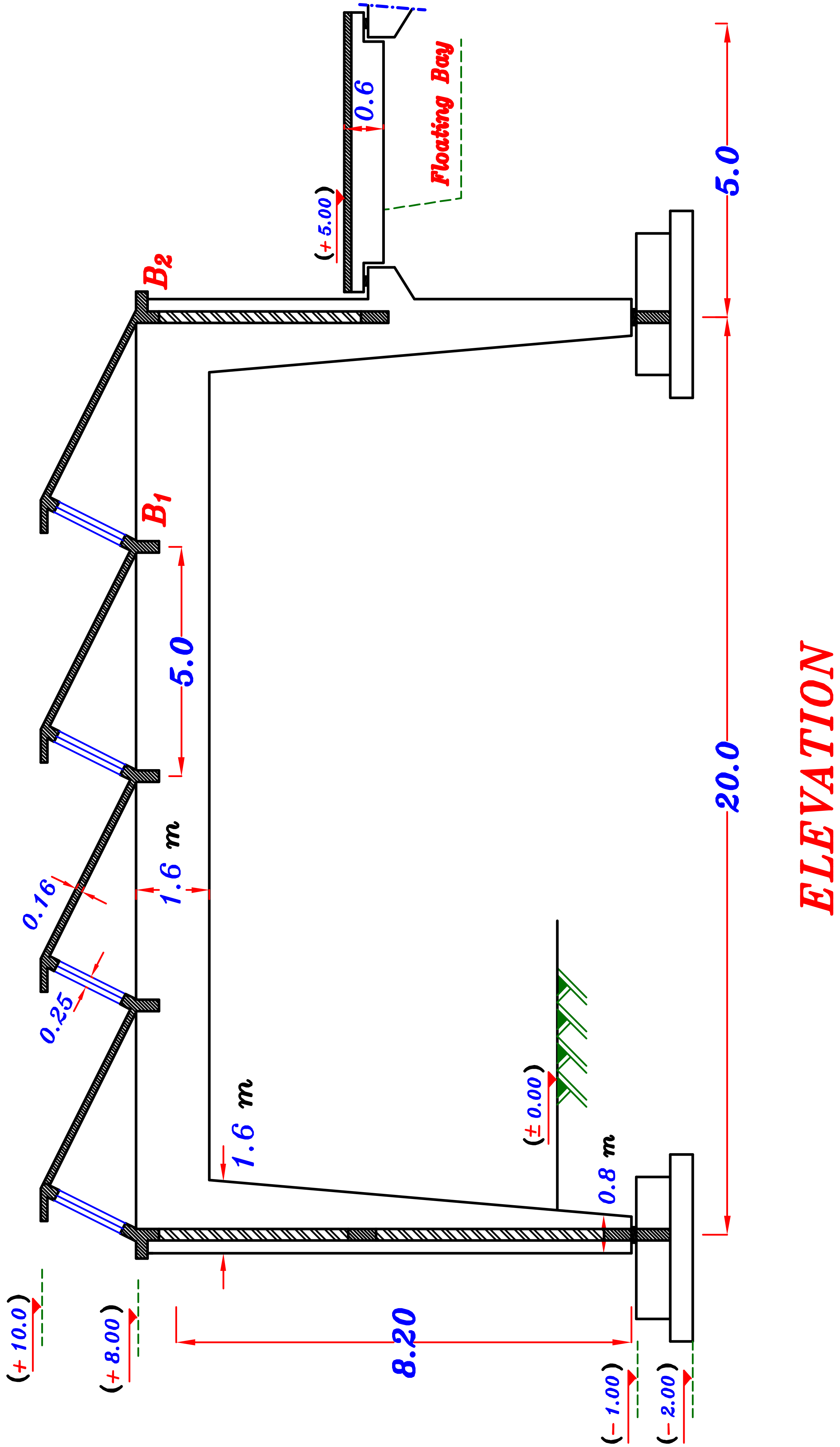
* Total loads (D.L.+L.L.) of the saw tooth roof are 5.0 $kN\backslash m^2$ H.P.
* $F_{cu} = 25 \quad N\backslash mm^2 \qquad F_y = 360 \quad N\backslash mm^2$
* $t_s = 160$ mm

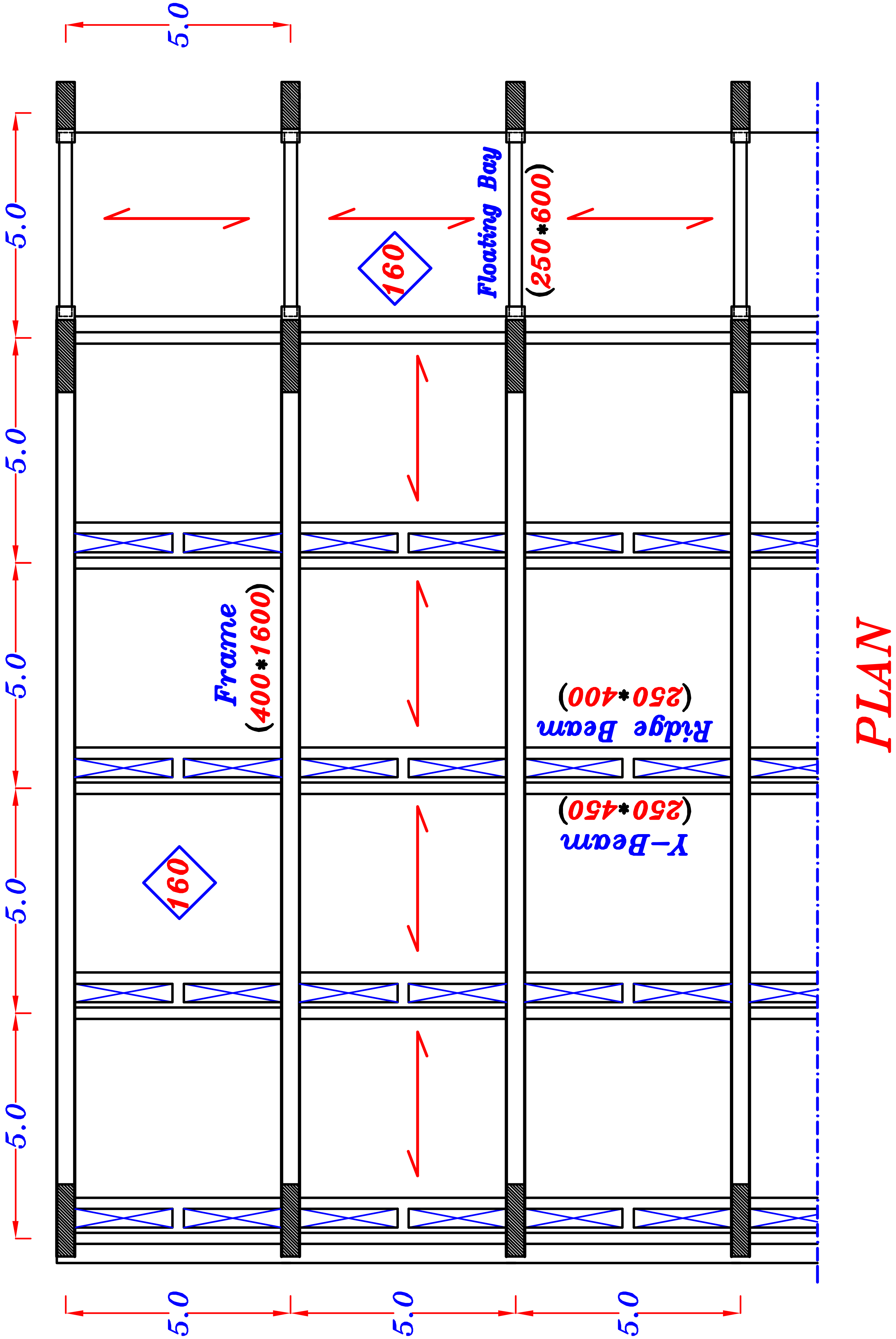
Required :

1– Without any calculations, but with reasonably assumed Concrete dimensions, Draw to scale 1:50 sectional elevation Z–Z (For the dotted area L,M,N,O)
Showing all concrete elements including Foundations.

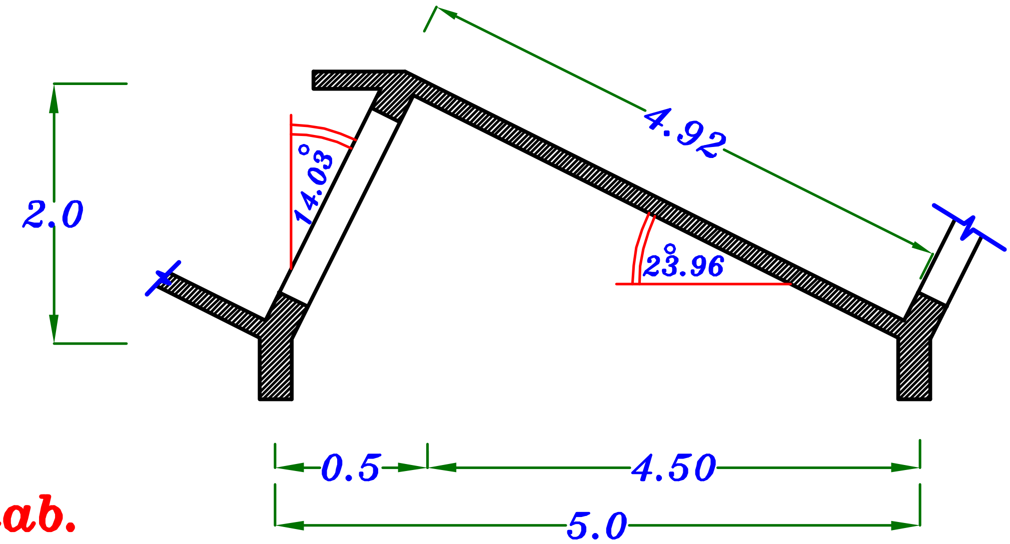
2– Design the saw tooth slab and it's elements.

3– Design one of the intermediate main elements a,b,c,d & e,F and show Details of Reinforcement on sectional elevation to scale 1:50


B2
B1
Floating Bay
0.6
(+5.00)
5.0
5.0
20.0
0.16
0.25
1.6 m
1.6 m
0.8 m
(±0.00)
8.20
(+10.0)
(+8.00)
(−1.00)
(−2.00)
ELEVATION


5.0
Floating Bay
(250*600)
160
Frame
(400*1600)
Ridge Beam
(250*400)
Y-Beam
(250*450)
PLAN

2- Design the Saw Tooth Slab.

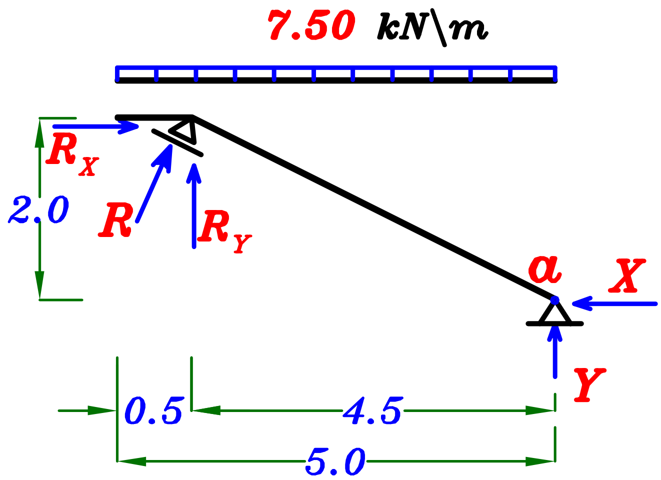


Strip in the Slab.

$$(w_s)_{working} = 5.0 \ kN\backslash m^2 \ H.P.$$

$$(w_s)_{U.L.} = 1.5 * 5.0$$

$$= 7.50 \ kN\backslash m^2 \ H.P.$$



$$R_Y = R \ Cos \ 14.03^\circ$$

$$R_X = R \ Sin \ 14.03^\circ$$

$$\because \sum M_a = Zero$$

$$\therefore 7.50\,(5)\,(2.5) - R \ Cos \ 14.03^\circ \ (4.5) - R \ Sin \ 14.03^\circ \ (2.0) = Zero$$

$$\therefore R = 19.32 \ kN\backslash m`$$

$$\therefore R_Y = R \ Cos \ \beta = (19.32) \ Cos \ 14.03^\circ = 18.74 \ kN\backslash m`$$

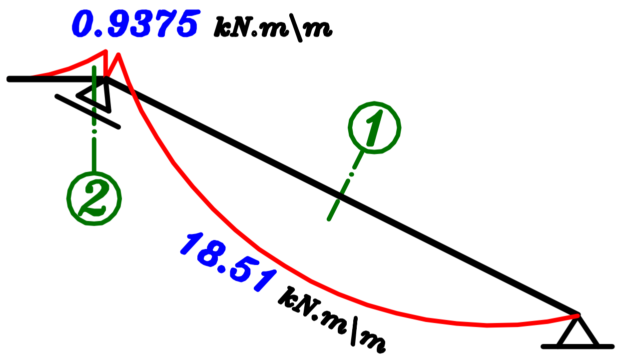
$$R_X = R \ Sin \ \beta = (19.32) \ Sin \ 14.03^\circ = 4.68 \ kN\backslash m`$$

$$X = R_X = 4.68 \ kN\backslash m`$$

$$Y = 7.50\,(5) - 18.74 = 18.76 \ kN\backslash m`$$

Design the Slab.

$\boxed{t_s = 160\ mm}$ as ginev in data



Sec. 1

$M_{U.L.} = 18.51\ kN.m\backslash m$, $t_s = 160\ mm$, $d = 160 - 20 = 140\ mm$

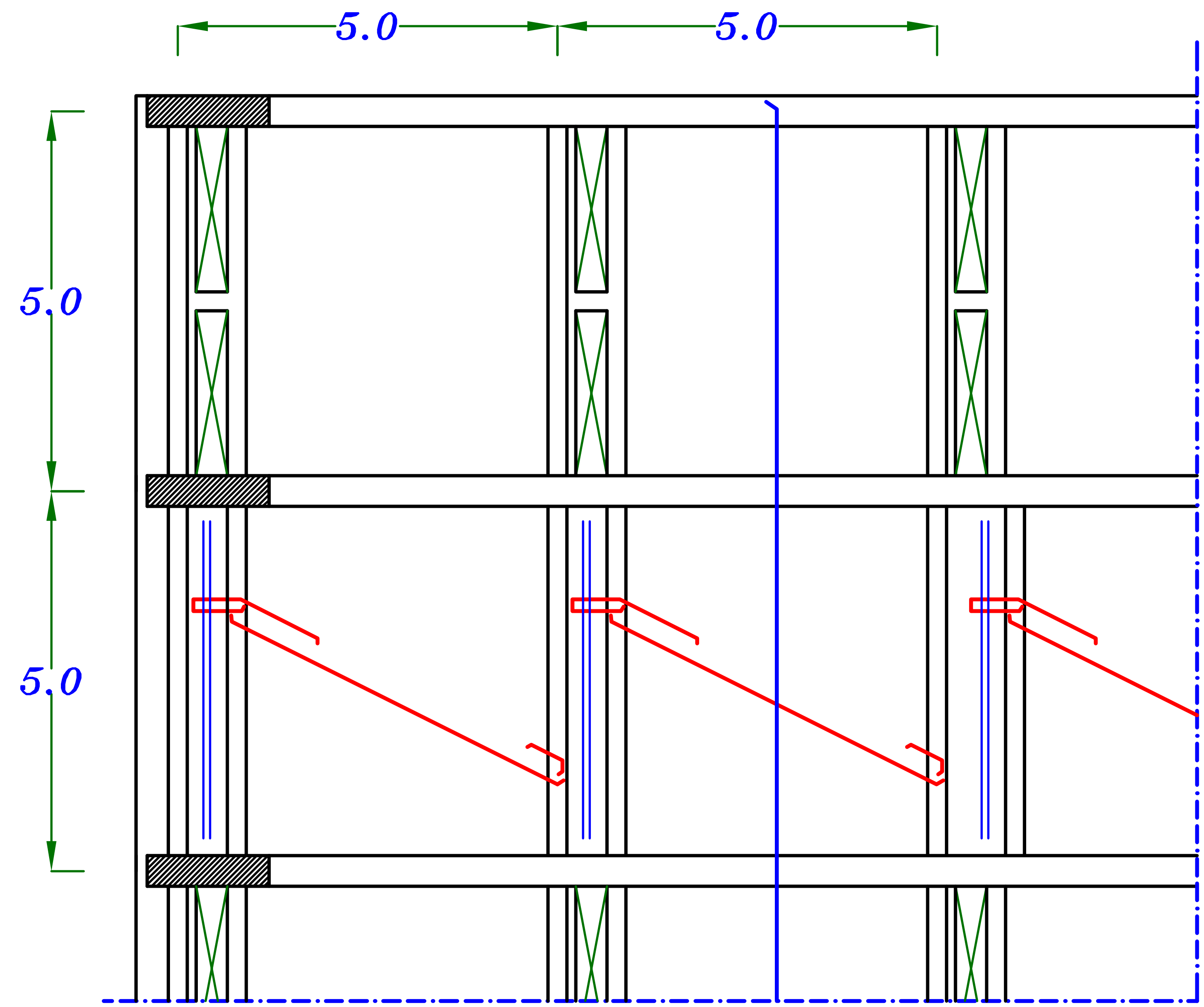
$$140 = C_1\sqrt{\frac{18.51 * 10^6}{25 * 1000}} \longrightarrow C_1 = 5.14 \longrightarrow J = 0.826$$

$$A_s = \frac{18.51 * 10^6}{0.826 * 360 * 140} = 444\ mm^2/m`$$

$6\ \phi\ 10 \backslash m`$

Sec. 2

$5\ \phi\ 10 \backslash m`$



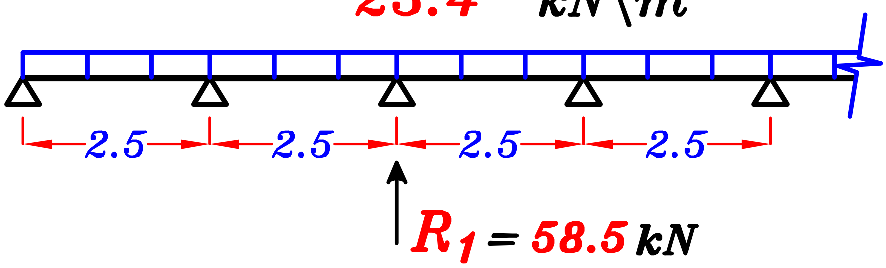
Ridge Beam. (250 * 400)

Take Distance between Posts. $a = 2.50$ m.

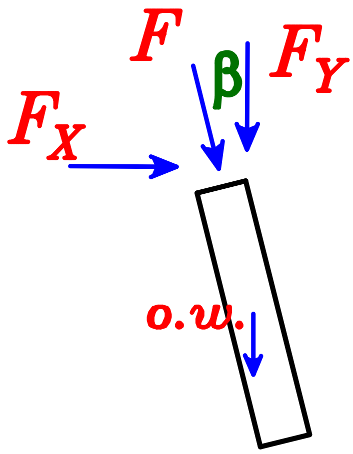
$$\boxed{w = R + O.W. * \cos\beta}$$

$$w = 19.32 + 4.20 * \cos 14.03^\circ = 23.4 \ kN\backslash m$$

$$\boxed{R_1 = w * a} \qquad R_1 = 23.4 * 2.5 = 58.5 \ kN$$



Post. (250*250) $\boxed{4\phi 12}$



$$\boxed{F = R_1 + O.W. (Post) * \cos\beta}$$

$$F = 58.5 + 3.50 * \cos 14.03^\circ = 61.9 \ kN$$

$$\boxed{F_Y = F * \cos\beta}$$

$$F_Y = 61.9 * \cos 14.03^\circ = 60.0 \ kN$$

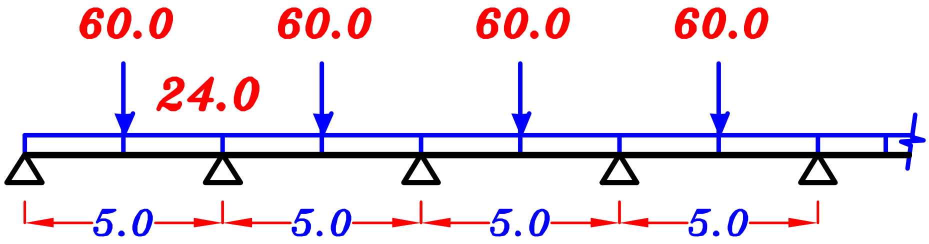
Y–Beam.

Take $t = \frac{Spacing}{12} = \frac{5.0}{12} = 0.41 = 0.45$ m

Take Y–Beam (250*600)

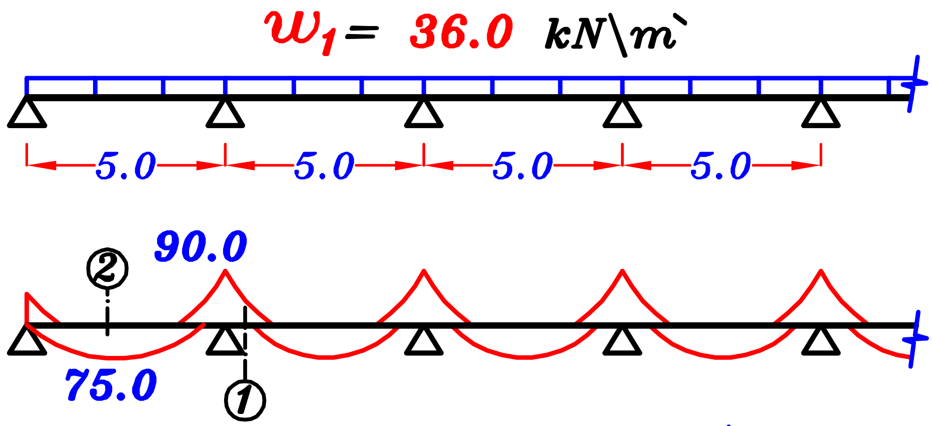
$$o.w. = 1.4\, b\, t\, \gamma_c = 1.4 * 0.25 * 0.60 * 25 = 5.25 \ kN\backslash m'$$

$$w = o.w.\,(beam) + Y = 5.25 + 18.76 = 24.0 \ kN\backslash m$$



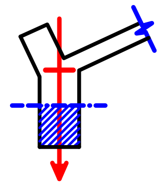
$$\boxed{w_1 = w + \frac{\sum F_Y \ (at\ one\ span)}{Span}}$$

$$w_1 = 24.0 + \frac{60.0}{5.0} = 36.0 \quad kN\backslash m$$



Sec. 1

$M_{U.L.} = 90.0$ kN.m R–sec.



$$550 = C_1 \sqrt{\frac{90.0 * 10^6}{25 * 250}} \rightarrow C_1 = 4.58 \rightarrow J = 0.818$$

$$A_s = \frac{90.0 * 10^6}{0.818 * 360 * 550} = 555.6 \ mm^2$$

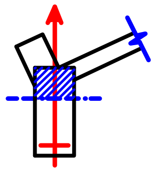
Check $A_{s\,min.}$ $\qquad A_{s_{req.}} = 555.6 \quad mm^2$

$$\mu_{min.}\, b\, d = \left(0.225 * \frac{\sqrt{F_{cu}}}{F_y}\right) b\, d = \left(0.225 * \frac{\sqrt{25}}{360}\right) 250 * 550 \quad = 429.7\, mm^2$$

$\therefore A_{s_{req.}} > \mu_{min.}\, b\, d \quad \therefore$ Take $A_s = A_{s_{req.}} = 555.6\ mm^2$ $\qquad$ 3 ϕ16

$$\therefore\ n = \frac{b - 25}{\phi + 25} = \frac{250 - 25}{16 + 25} = 5.48 = 5.0 \text{ bars}$$

Sec. ② $\qquad M_{U.L.} = 75.0\ kN.m \qquad$ R−sec.



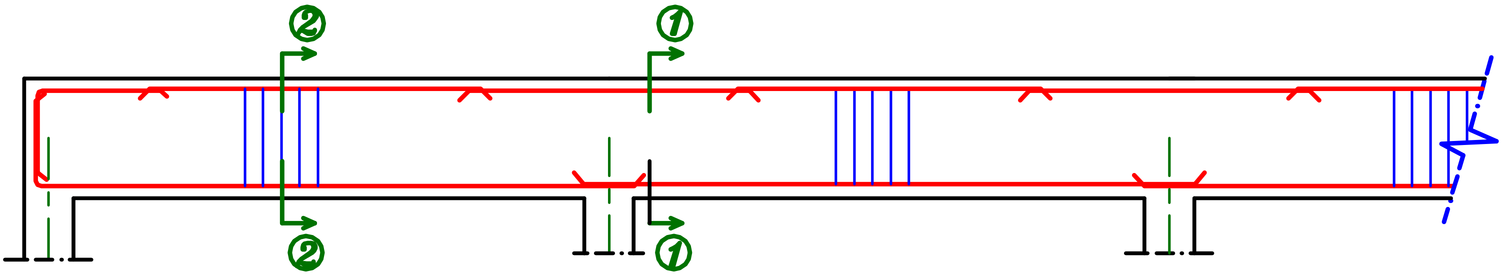
$$550 = C_1 \sqrt{\frac{75.0 * 10^6}{25 * 250}} \longrightarrow C_1 = 5.02 \quad \longrightarrow J = 0.826$$

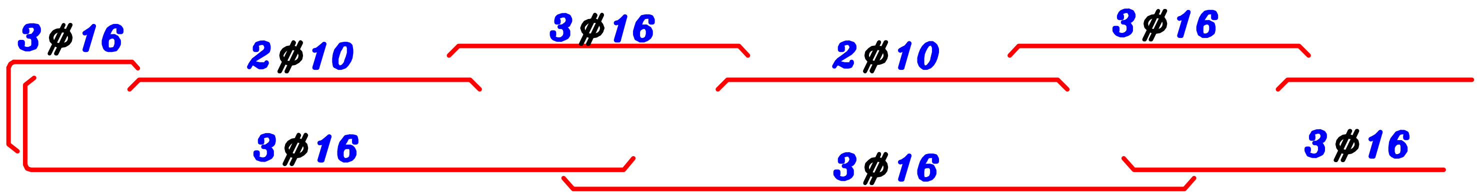
$$A_s = \frac{75.0 * 10^6}{0.826 * 360 * 550} = 458.5\ mm^2$$

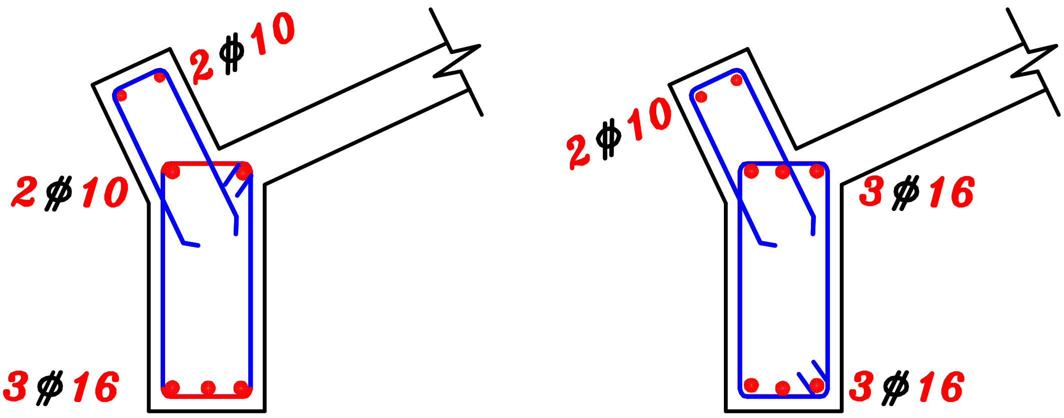
Check $A_{s\,min.}$ $\qquad A_{s_{req.}} = 458.5 \quad mm^2$

$$\mu_{min.}\, b\, d = \left(0.225 * \frac{\sqrt{F_{cu}}}{F_y}\right) b\, d = \left(0.225 * \frac{\sqrt{25}}{360}\right) 250 * 550 \quad = 429.7\, mm^2$$

$\therefore A_{s_{req.}} > \mu_{min.}\, b\, d \quad \therefore$ Take $A_s = A_{s_{req.}} = 458.5\ mm^2$ $\qquad$ 3 ϕ16

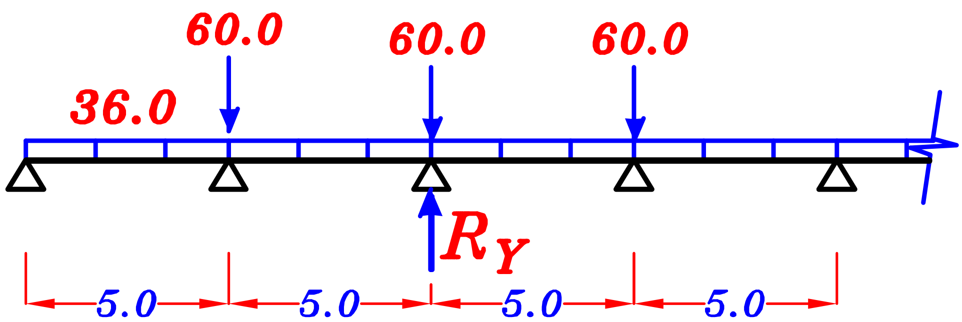






Sec. (2-2) Sec. (1-1)

Reaction of Y-Beam.



$$\boxed{R_Y = w_1 * S + F_Y}$$

$$R_Y = 36.0 * 5.0 + 60.0 = 240.0 \text{ kN}$$

End Beam

VL. Beam $w_{VL.} = O.W. + Y = 7.0 + 18.76 = 25.76 \ kN\backslash m$

$R_{VL.} = w_{VL.} * S = 25.76 * 5.0 = 128.8 \ kN$

HL. Beam $w_{HL.} = X = 4.68 \ kN\backslash m$

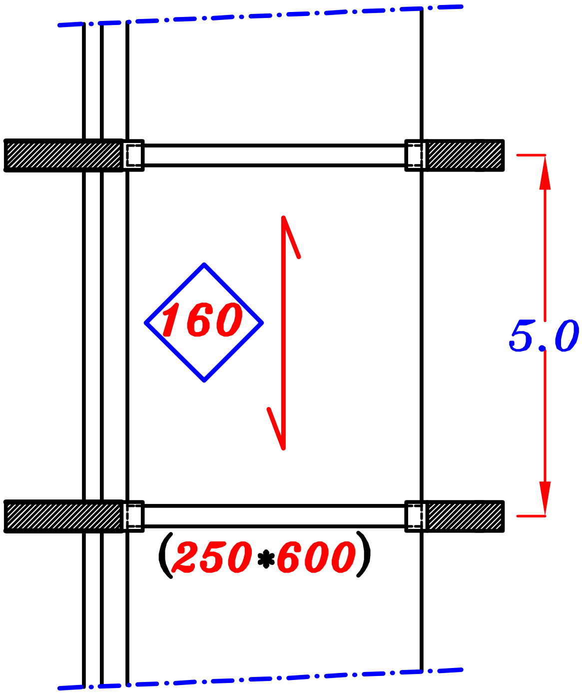
$R_{HL.} = X * S = 4.68 * 5.0 = 23.4 \ kN$

Floating Bay. (250*600)

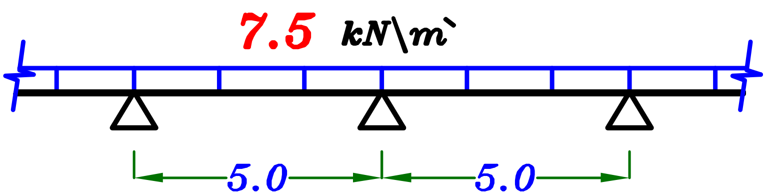
$$t_s = \frac{5000}{30} = 166 \ mm$$

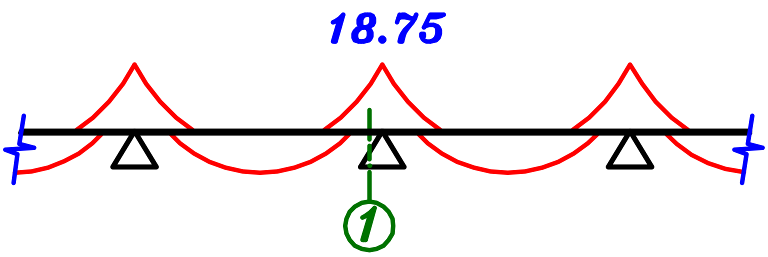
$$\boxed{t_s = 160 \ mm}$$

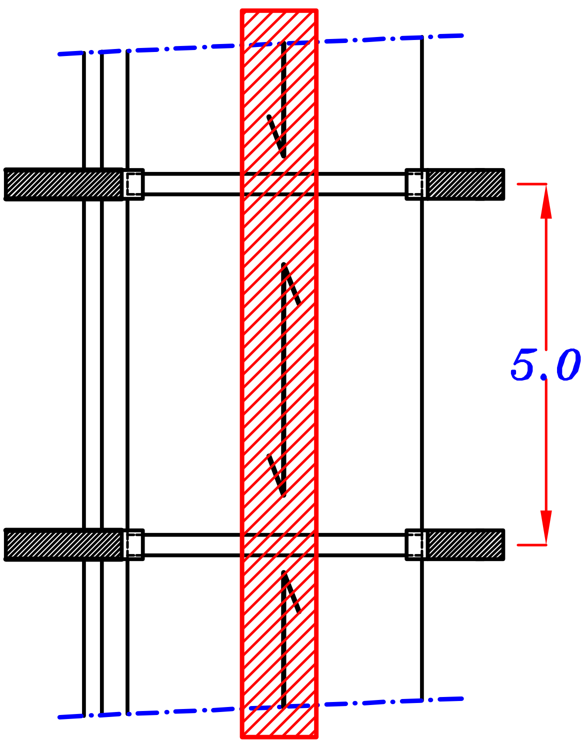
$$(w_s)_{U.L.} = 1.5 * 5.0 = 7.50 \ kN\backslash m^2$$



Design the slab.







Sec. 1

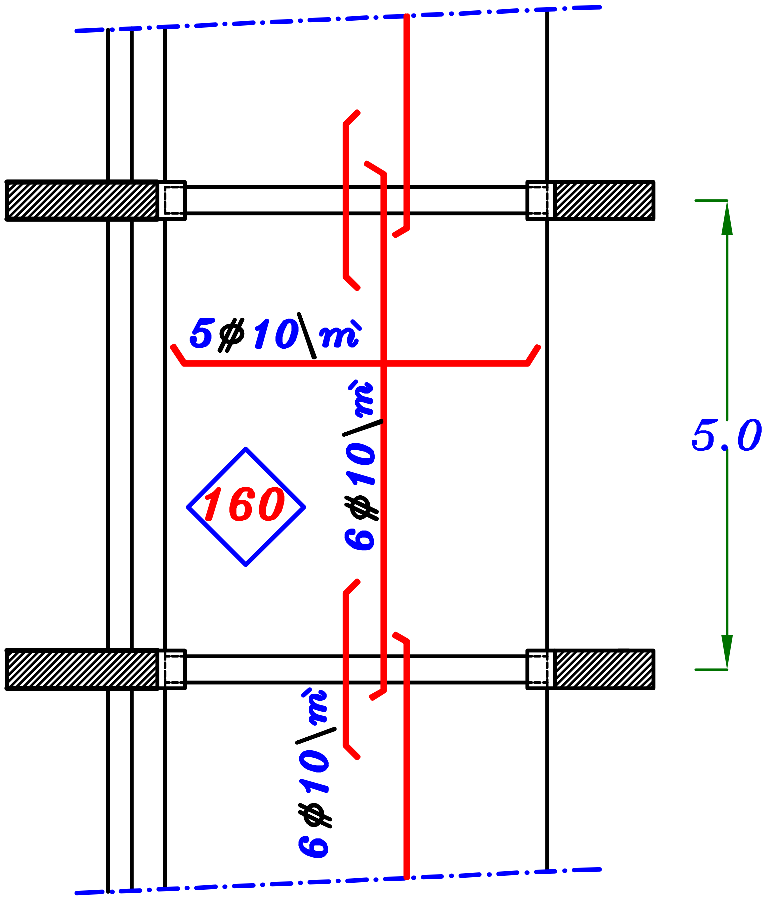
$$M_{U.L.} = 18.75 \ kN.m\backslash m$$

$$140 = C_1 \sqrt{\frac{18.75 * 10^6}{25 * 1000}} \longrightarrow C_1 = 5.11$$

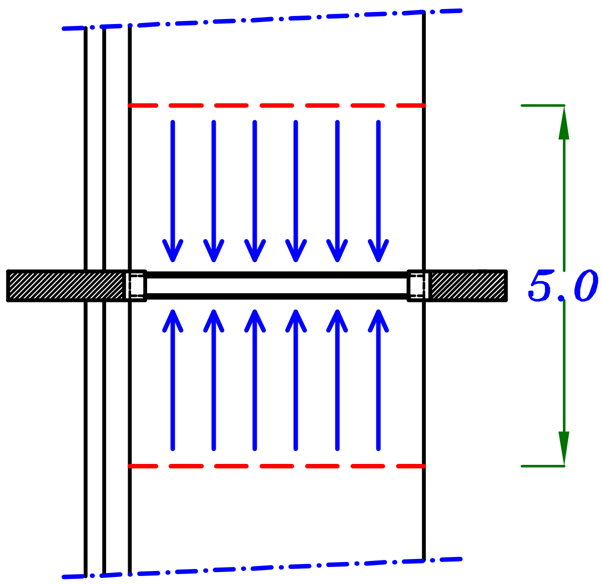
$$\longrightarrow J = 0.826$$

$$A_s = \frac{18.75 * 10^6}{0.826 * 360 * 140} = 450 \ mm^2/m`$$

$$6 \phi 10 \backslash m`$$

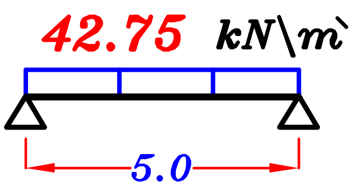


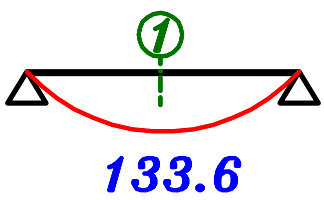
Design the Floating Bay.



$$o.w. = 1.4\, b\, t\, \gamma_c = 1.4 * 0.25 * 0.60 * 25 = 5.25 \ kN\backslash m`$$

$$w = o.w. + 2\, w_s\, \frac{L_s}{2} = 5.25 + 2\,(7.50)\,\left(\frac{5.0}{2}\right) = 42.75 \ kN\backslash m`$$





Sec. 1 $M_{U.L.} = 133.6$ kN.m **T-sec.**

$$B = \begin{cases} C.L.-C.L. = 5.0\ m = 5000\ mm \\ 16\ t_s + b = 16*160+250 = 2810\ mm \\ K\ \frac{L}{5} + b = 1.0 * \frac{5000}{5} + 250 = 1250\ mm \end{cases}$$

$$\boxed{B = 1250\ mm}$$

$$550 = C_1 \sqrt{\frac{133.6*10^6}{25*1250}} \longrightarrow C_1 = 8.41 \longrightarrow J = 0.826$$

$$A_s = \frac{133.6*10^6}{0.826*360*550} = 816.9\ mm^2$$

Check $A_{s\,min.}$ $A_{s_{req.}} = 816.9\ mm^2$

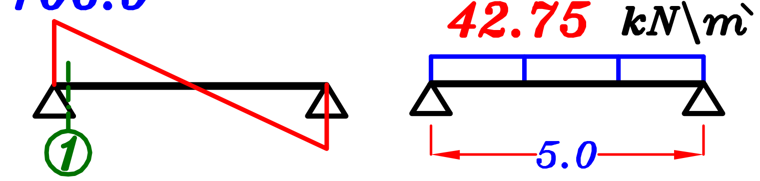
$$\mu_{min.}\, b\, d = \left(0.225 * \frac{\sqrt{F_{cu}}}{F_y}\right) b\, d = \left(0.225 * \frac{\sqrt{25}}{360}\right) 250*550 = 429.7\ mm^2$$

$$\therefore A_{s_{req.}} > \mu_{min.}\, b\, d \quad \therefore Take\ A_s = A_{s_{req.}} = 816.9\ mm^2$$

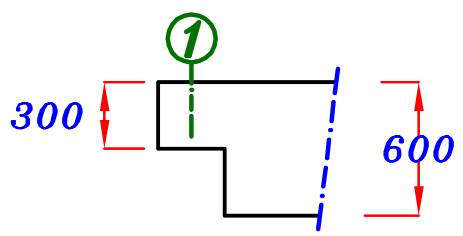
5 ϕ16

$$\therefore n = \frac{b-25}{\phi+25} = \frac{250-25}{16+25} = 5.48 = 5.0\ bars$$

Check Shear.



Sec. 1



$$q_{cu} = (0.24)\sqrt{\frac{25}{1.50}} = 0.98\ N\backslash mm^2$$

$$q_{u_{max}} = (0.70)\sqrt{\frac{25}{1.50}} = 2.85\ N\backslash mm^2$$

$$q_u = \frac{Q_{max}}{b\, d} = \frac{106.9*10^3}{250*250} = 1.71\ N\backslash mm^2$$

$\therefore\ q_{cu} < q_U < q_{max.}$ $\therefore$ We need Stirrups more Than $5\phi 8 \backslash m'$

$\therefore$ Use $q_s = q_u - \dfrac{q_{cu}}{2} = \dfrac{n\,A_s (F_y \backslash \delta_s)}{b\ \ S}$

* Take $n = 2$, $\phi\ 8 \longrightarrow A_s = 50.3\ mm^2$

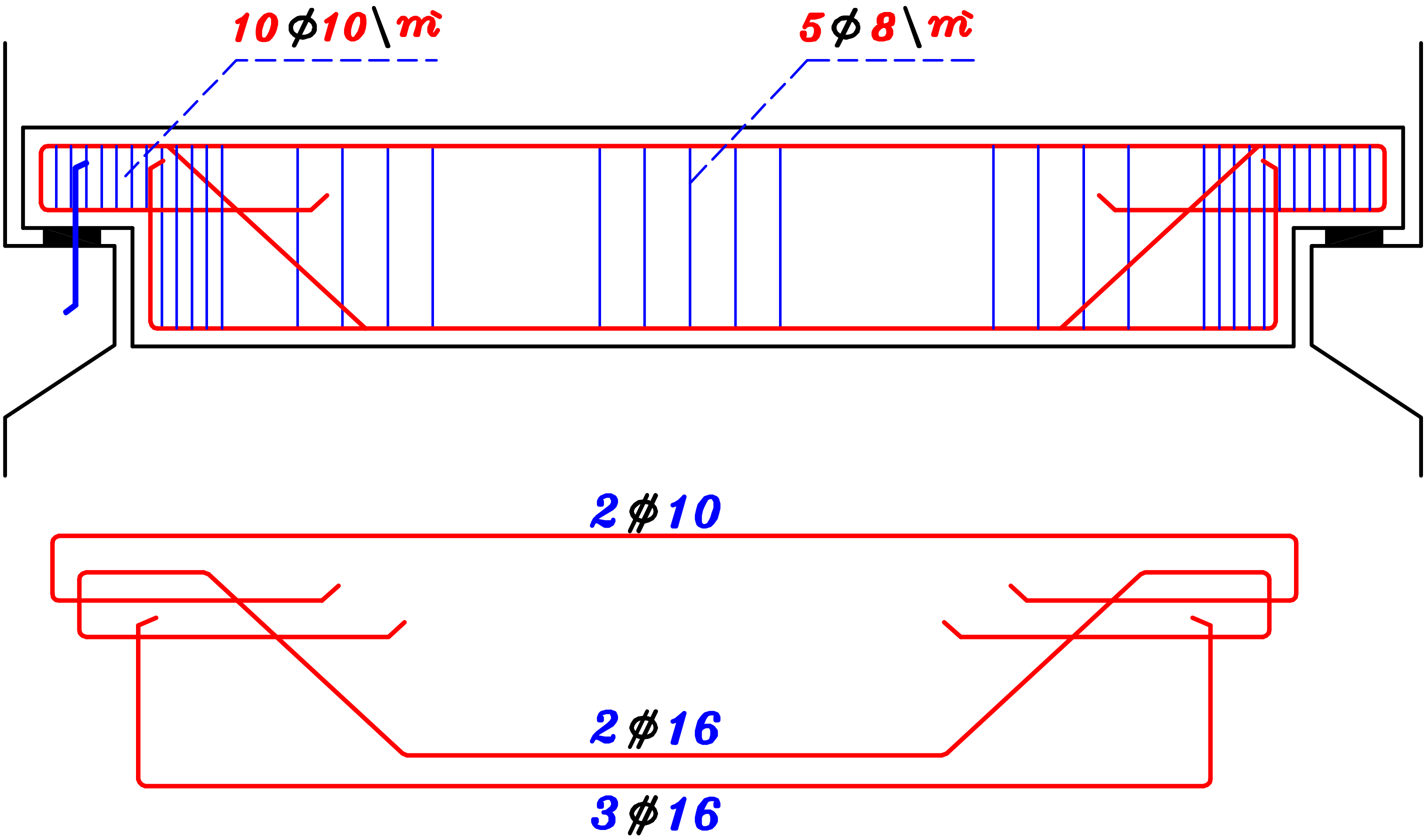
$$1.71 - \frac{0.98}{2} = \frac{2 * 50.3\ (240 \backslash 1.15)}{250 * S} \longrightarrow S = 68.8\ mm < 100\ mm$$

* Take $n = 2$, $\phi\ 10 \longrightarrow A_s = 78.5\ mm^2$

$$1.71 - \frac{0.98}{2} = \frac{2 * 78.5\ (240 \backslash 1.15)}{250 * S} \longrightarrow S = 107.4\ mm > 100\ mm \therefore o.k.$$

$\therefore$ No. of stirrups$\backslash m' = \dfrac{1000}{S} = \dfrac{1000}{107.4} = 9.30 = 10 \backslash m'$

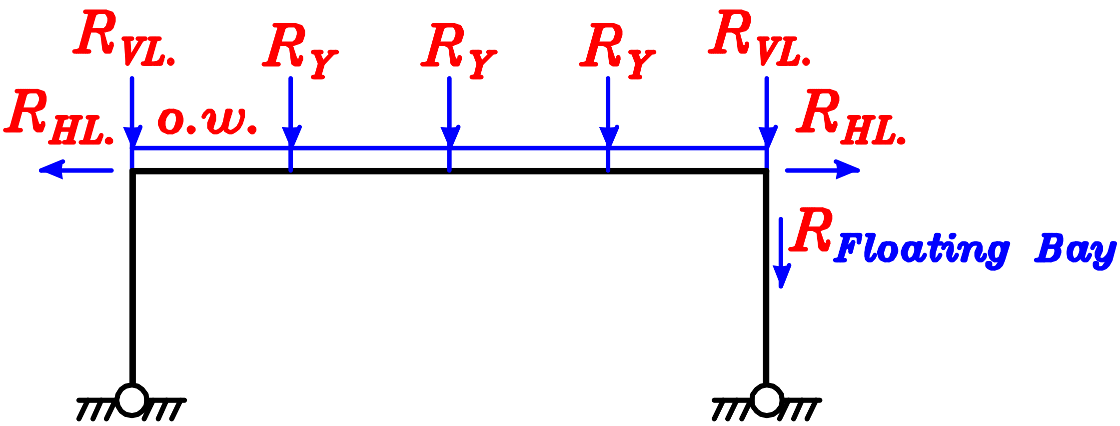
$\therefore$ Use Stirrups $\boxed{10\phi 10 \backslash m'}$ 2 branches

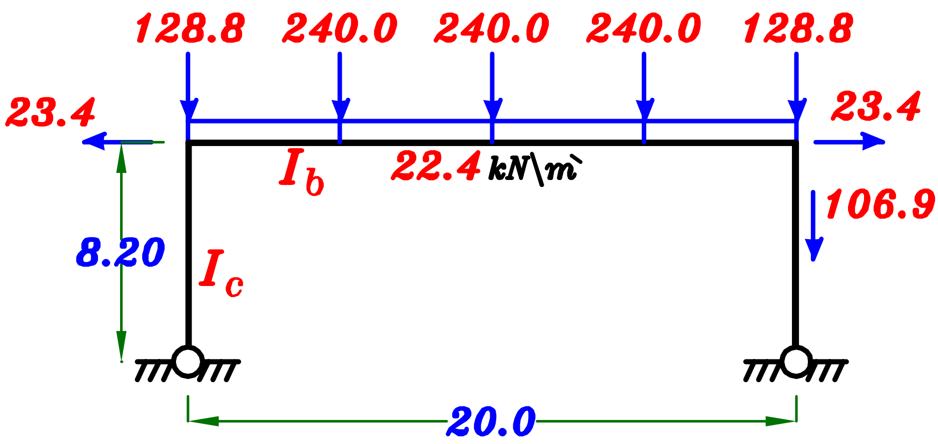


Design the Frame.

Loads on Frame.

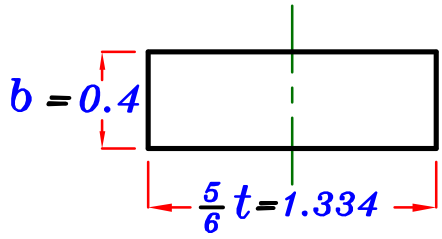
$$o.w. = 1.4\, b\, t\, \gamma_c = 1.4 * 0.40 * 1.60 * 25 = 22.4 \text{ kN\m`}$$





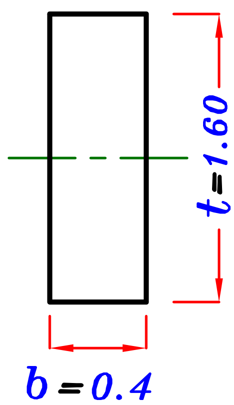
Solve the Frame using Moment Distribution.

I_c



$$I_c = \frac{b\left(\frac{5}{6} t\right)^3}{12} = \frac{0.4\left(\frac{5}{6} * 1.6\right)^3}{12} = 0.0790 \ m^4$$

I_b



$$I_b = \frac{b * t^3}{12} = \frac{0.4\,(1.6)^3}{12} = 0.1365 \ m^4$$

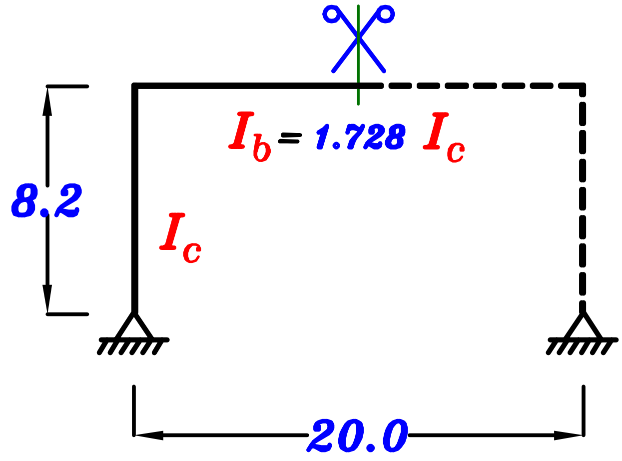
$$\therefore \boxed{I_b = 1.728\ I_c}$$

D.F.

$$K_c = \frac{3}{4} * \frac{I_c}{h} = \frac{3}{4} * \frac{I_c}{8.2} = 0.0915\ I_c$$

$$K_b = \frac{1}{2}\ \frac{I_b}{L} = \frac{1}{2} * \frac{1.728\ I_c}{20} = 0.0432\ I_c$$

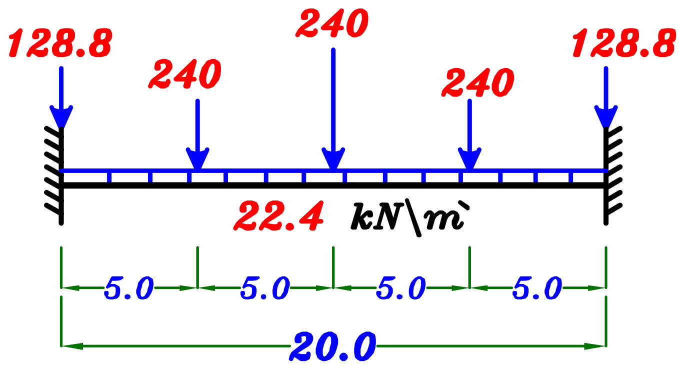
$$D.F._{(Col.)} = \frac{0.0915}{0.0915 + 0.0432} = 0.68$$

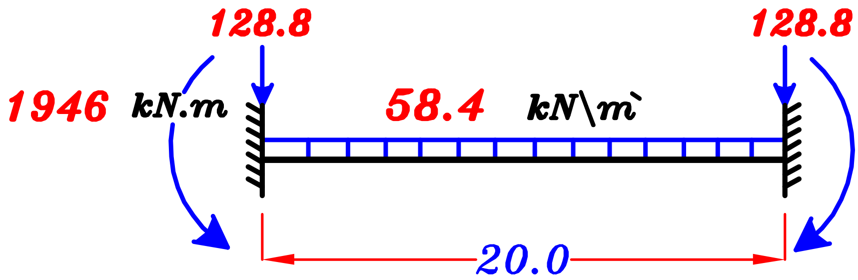


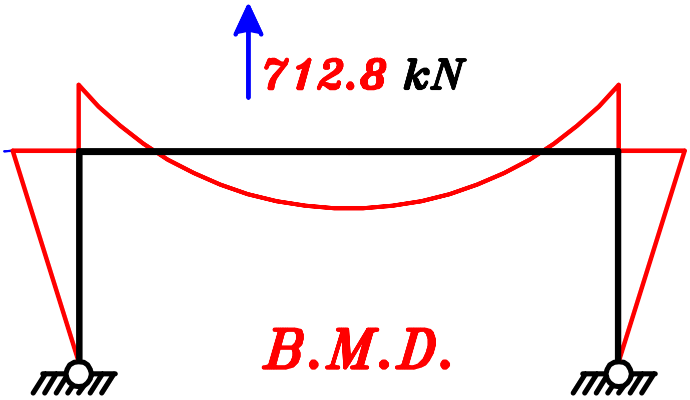
F.E.M.

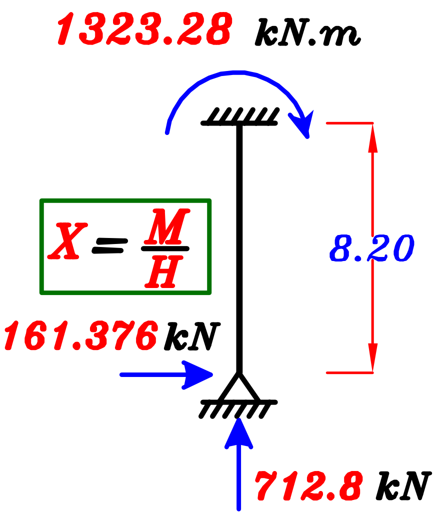
$$W = 22.4 + \frac{3\,(240)}{20} = 58.4\ \ kN\backslash m$$

$$F.E.M. = \frac{58.4 * 20^2}{12} = 1946\ \ kN.m$$



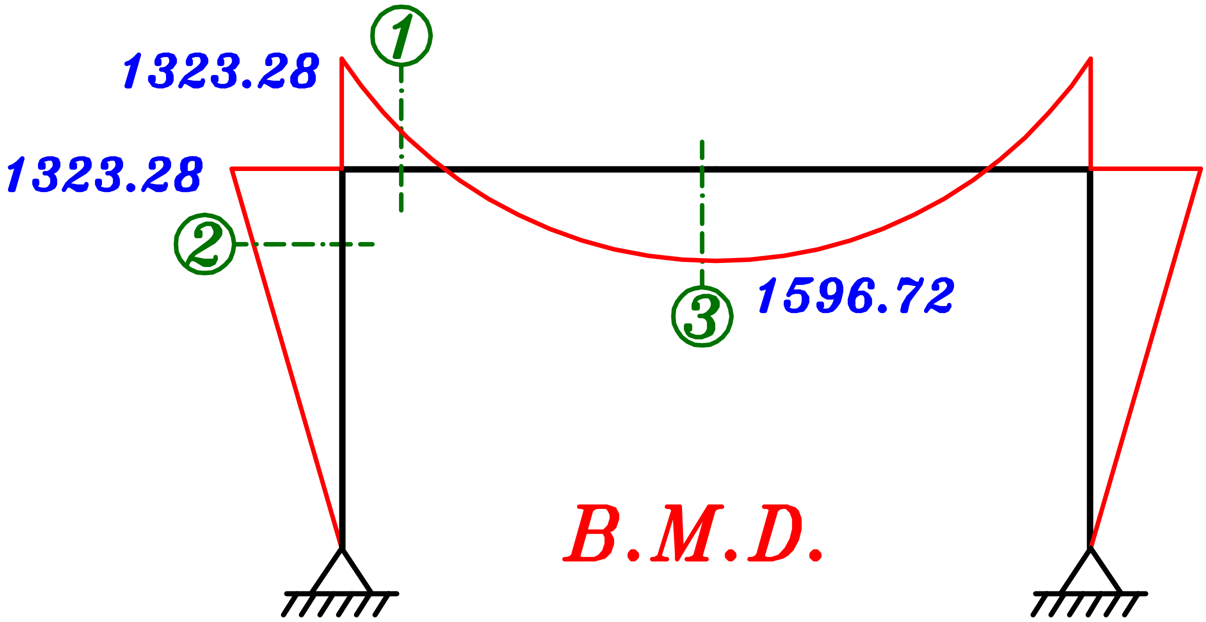


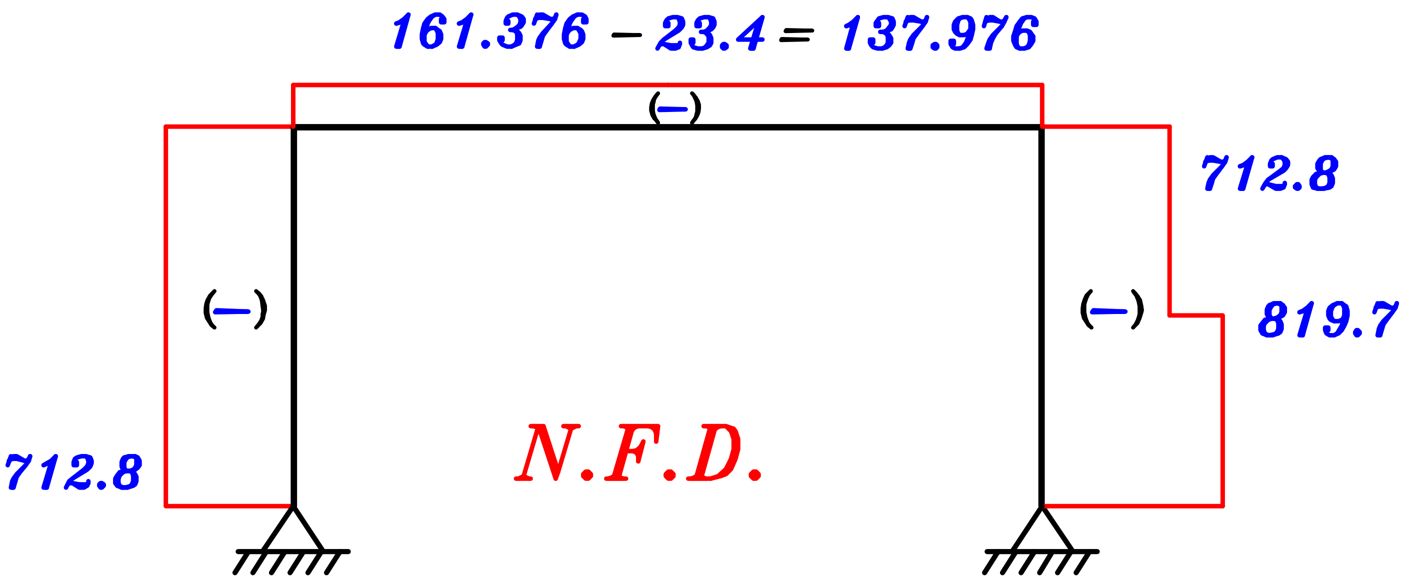




$$\boxed{X = \frac{M}{H}}$$

$$\boxed{F.E.M._{(Beam)} * D.F._{(Col.)} = 1946 * 0.68 = 1323.28\ \ kN.m}$$


1323.28
1323.28
1596.72
1
2
3
B.M.D.


161.376 − 23.4 = 137.976
(−)
712.8
819.7
(−)
(−)
712.8
N.F.D.

Design of Sections.

Sec. ① R–Sec.

$M = 1323.28$ kN.m , $P = 137.976$ kN , $b = 0.4$ m , $t = 1.60$ m

Check $\frac{P}{F_{cu}\, b\, t} = \frac{137.976 * 10^3}{25 * 400 * 1600} = 0.0086 < 0.04$ (neglect P)

$$\therefore 1500 = C_1 \sqrt{\frac{1323.28 * 10^6}{25 * 400}} \longrightarrow C_1 = 4.12 \longrightarrow J = 0.808$$

$$\therefore A_s = \frac{M_{U.L.}}{J\, F_y\, d} = \frac{1323.28 * 10^6}{0.808 * 360 * 1500} = 3033 \text{ mm}^2$$

Check $A_{s\,min.}$ $\qquad A_{s_{req.}} = 3033 \text{ mm}^2$

$$\mu_{min.}\, b\, d = \left(0.225 * \frac{\sqrt{F_{cu}}}{F_y}\right) b\, d = \left(0.225 * \frac{\sqrt{25}}{360}\right) 400 * 1500 = 1875 \text{ mm}^2$$

$\therefore A_{s_{req.}} > \mu_{min.}\, b\, d$ $\therefore$ Take $A_s = A_{s_{req.}} = 3033 \text{ mm}^2$ $\quad 12\phi18$

$$\therefore n = \frac{b - 25}{\phi + 25} = \frac{400 - 25}{18 + 25} = 8.70 = 8.0 \text{ bars}$$

Sec. ② R–Sec.

Neglect effect of Buckling.

$M = 1323.28$ kN.m , $P = 712.8$ kN

Check $\frac{P}{F_{cu}\, b\, t} = \frac{712.8 * 10^3}{25 * 400 * 1600} = 0.0445 > 0.04$ (Don't neglect P)

$$e = \frac{M}{P} = \frac{1323.28}{712.8} = 1.86 \text{ m} \quad \therefore \frac{e}{t} = \frac{1.86}{1.60} = 1.16 > 0.5 \xrightarrow{use} e_s$$

$$e_s = e + \frac{t}{2} - c = 1.86 + \frac{1.6}{2} - 0.1 = 2.56 \text{ m}$$

$$M_s = P * e_s = 712.8 * 2.56 = 1824.8 \text{ kN.m}$$

$$\therefore 1500 = C_1 \sqrt{\frac{1824.8 * 10^6}{25 * 400}} \longrightarrow C_1 = 3.51 \longrightarrow J = 0.782$$

$$\therefore A_s = \frac{M_s}{J\, F_y\, d} - \frac{P_{U.L.}}{(F_y \backslash \gamma_s)} = \frac{1824.8 * 10^6}{0.782 * 360 * 1500} - \frac{712.8 * 10^3}{(360 \backslash 1.15)}$$

$$= 2044.3 \ mm^2$$

Check $A_{s\,min.}$ $\quad A_{s\,req.} = 2044.3\ mm^2$

$$\mu_{min.}\, b\, d = \left(0.225 * \frac{\sqrt{F_{cu}}}{F_y}\right) b\, d = \left(0.225 * \frac{\sqrt{25}}{360}\right) 400 * 1500 = 1875\ mm^2$$

$$\therefore A_{s_{req.}} > \mu_{min.}\, b\, d \quad \therefore \text{Take } A_s = A_{s_{req.}} = 2044.3\ mm^2 \quad 9\phi 18$$

Sec. 3 $\quad$ **R-Sec.**

$M = 1596.72\ kN.m$, $P = 137.976\ kN$, $b = 0.4\ m$, $t = 1.60\ m$

$$\text{Check} \quad \frac{P}{F_{cu}\, b\, t} = \frac{137.976 * 10^3}{25 * 400 * 1600} = 0.0086 < 0.04 \quad (\text{neglect } P)$$

$$\therefore 1500 = C_1 \sqrt{\frac{1596.72 * 10^6}{25 * 400}} \longrightarrow C_1 = 3.75 \longrightarrow J = 0.794$$

$$\therefore A_s = \frac{M_{U.L.}}{J\, F_y\, d} = \frac{1596.72 * 10^6}{0.794 * 360 * 1500} = 3724\ mm^2$$

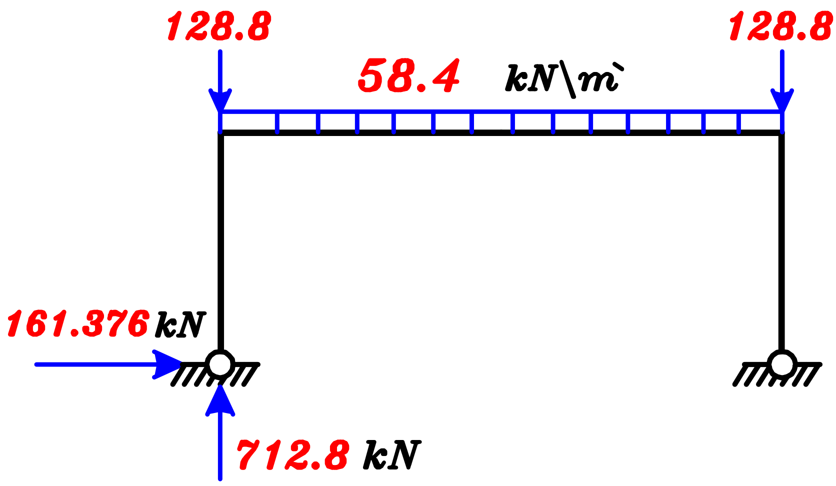
Check $A_{s\,min.}$ $\quad A_{s_{req.}} = 3724\ mm^2$

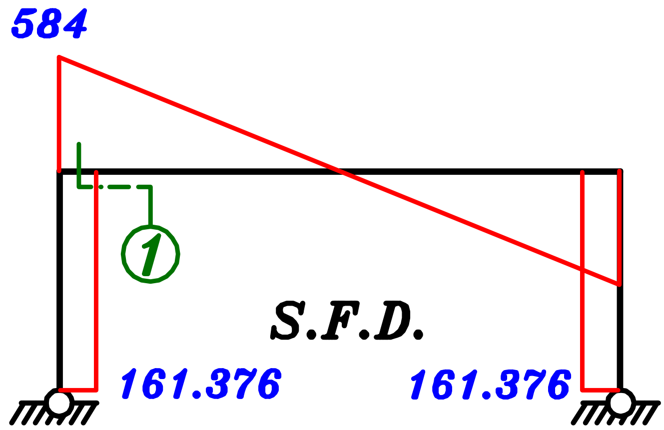
$$\mu_{min.}\, b\, d = \left(0.225 * \frac{\sqrt{F_{cu}}}{F_y}\right) b\, d = \left(0.225 * \frac{\sqrt{25}}{360}\right) 400 * 1500 = 1875\ mm^2$$

$$\therefore A_{s_{req.}} > \mu_{min.}\, b\, d \quad \therefore \text{Take } A_s = A_{s_{req.}} = 3724\ mm^2 \quad 10\phi 22$$

$$\therefore n = \frac{b - 25}{\phi + 25} = \frac{400 - 25}{22 + 25} = 8.70 = 8.0 \text{ bars}$$

Check Shear.





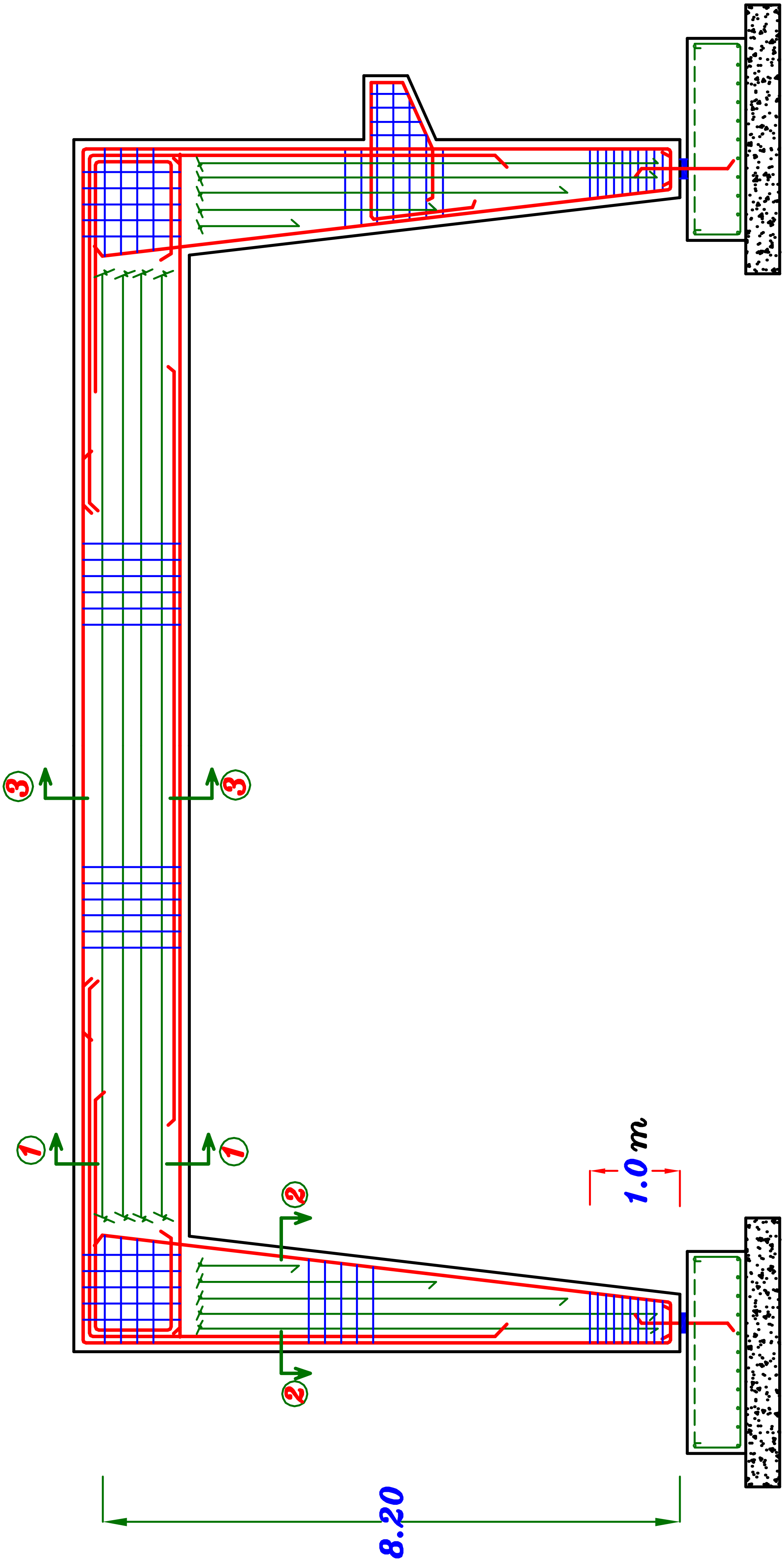
Sec. 1

$$q_{cu} = (0.24)\sqrt{\frac{25}{1.50}} = 0.98 \quad N\backslash mm^2$$

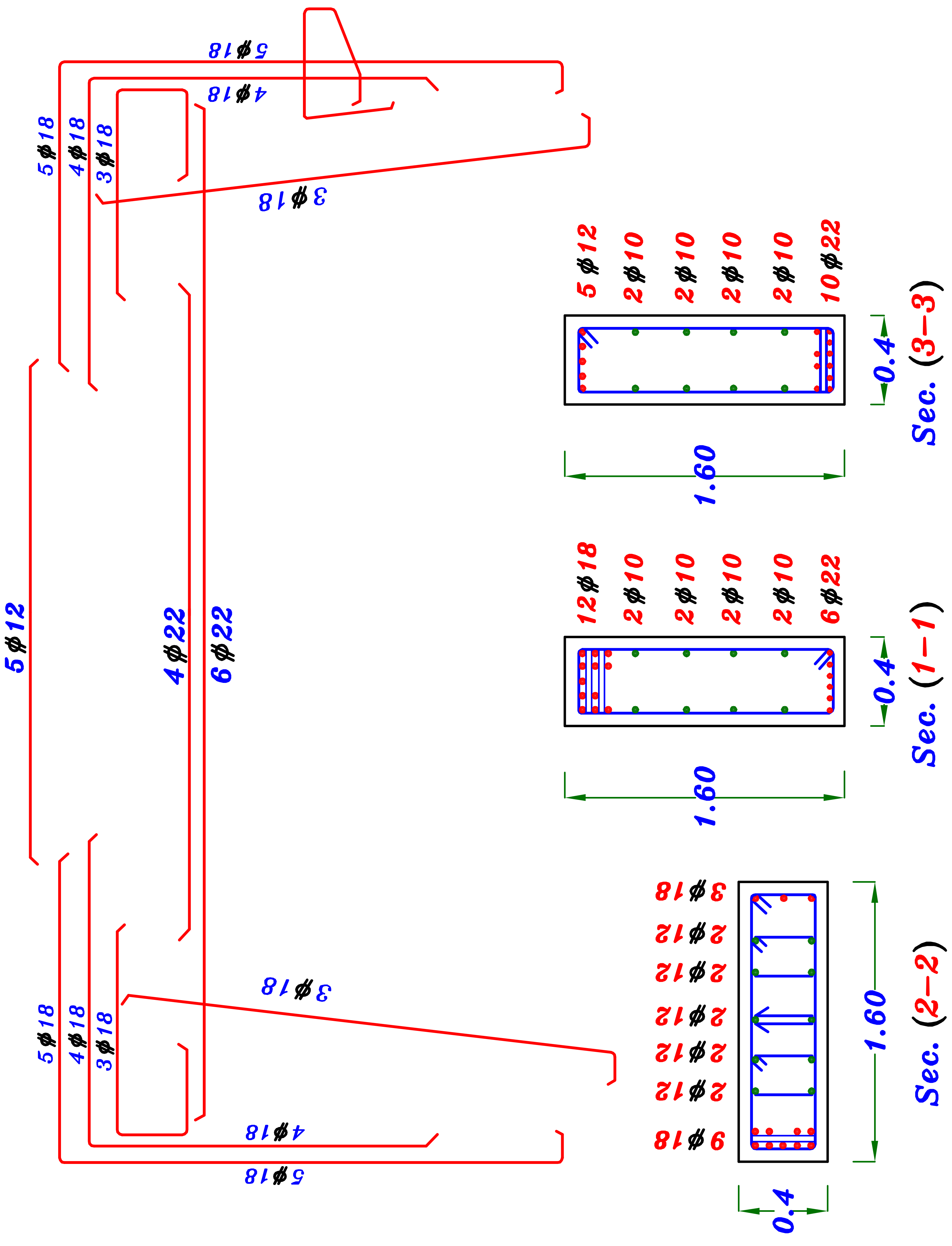
$$q_{u_{max}} = (0.70)\sqrt{\frac{25}{1.50}} = 2.85 \quad N\backslash mm^2$$

$$q_u = \frac{Q_{max}}{b\ d} = \frac{584 * 10^3}{400 * 1500} = 0.97 \quad N\backslash mm^2 \qquad \because \quad q_u < q_{cu}$$

$\therefore$ Use min. Shear RFT. $\quad 5\phi 8\backslash m'$



3
3
1
1
2
2
1.0 m
8.20


5ϕ18
4ϕ18
3ϕ18
5ϕ12
4ϕ22
6ϕ22
5ϕ12
2ϕ10
2ϕ10
2ϕ10
2ϕ10
10ϕ22
0.4
1.60
Sec. (3-3)
12ϕ18
2ϕ10
2ϕ10
2ϕ10
2ϕ10
6ϕ22
0.4
1.60
Sec. (1-1)
3ϕ18
2ϕ12
2ϕ12
2ϕ12
2ϕ12
2ϕ12
9ϕ18
1.60
0.4
Sec. (2-2)

Example.

Figure (1) shows an U-shape Factory hall and its accompanied 7-stories office building. The Factory hall is covered with a north light saw-tooth roof R.C. structure. The corridor between the Factory hall and the office building is covered with Floating bay hollow block slab panel. Considering the given north direction and that the columns are only allowed along the axes A, B, C, D, 1, 3 & 2/B-C each 5.0 m.

It is required to proceed with the Following:

1- Choose a reasonable structural system For the north light saw-tooth R.C. roof and draw to scale 1:50 a part plan and sections X-X & Z-Z showing the chosen concrete dimensions of the slab system, the main supporting elements and the slab system of the corridor.

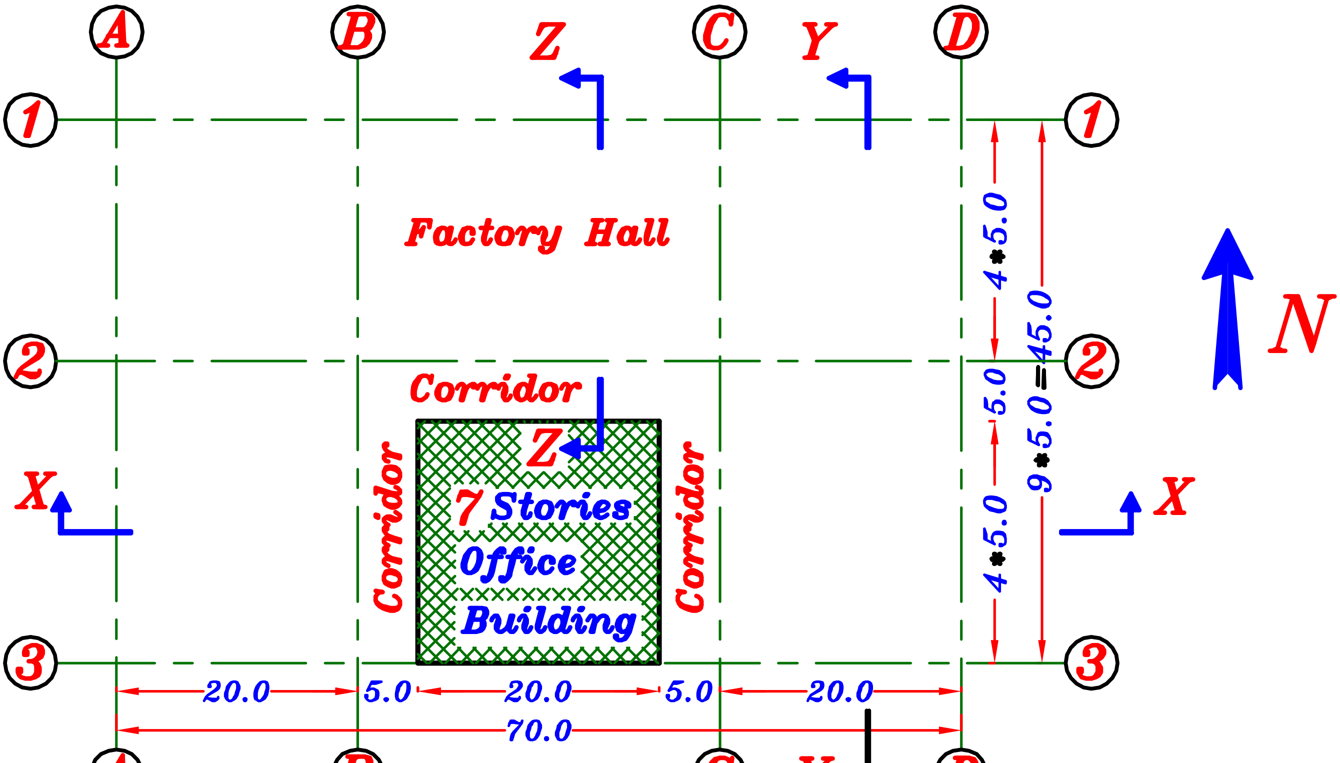
2- For an intermediate main supporting element in the region bounded by axes 2, 3 & A, B It is required to:

a) Calculate its design loads and the internal Forces.

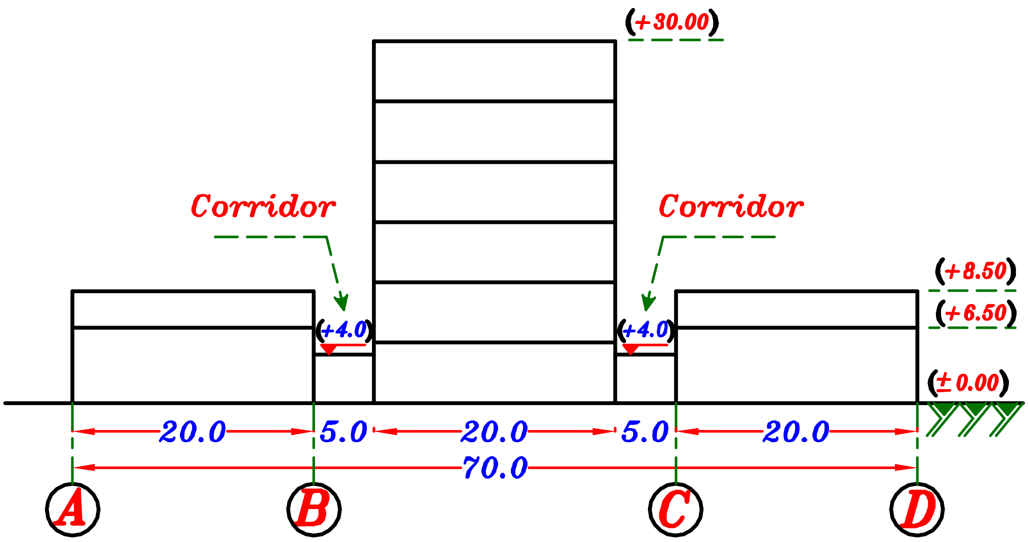
b) Design this main supporting element and draw to a reasonable scale its detailing of reinforcement in elevation and sections.

Design Data :

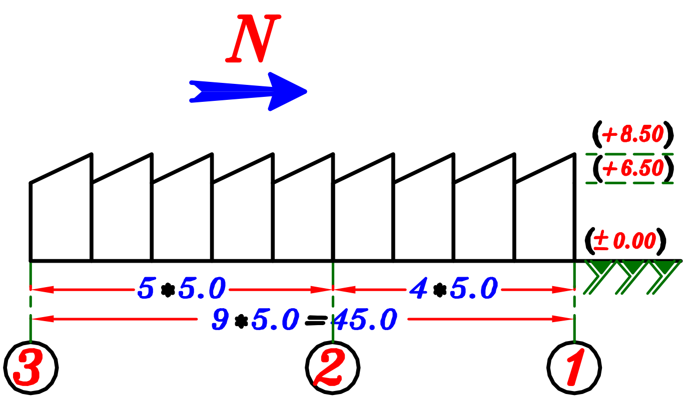
- $F_{cu} = 30 \ N\backslash mm^2$, $F_y = 360 \ N\backslash mm^2$
- $L.L. = 1.50 \ kN\backslash m^2$, $F.C. = 1.0 \ kN\backslash m^2$
- Total Load of H.B. slab in the corridor = $10.0 \ kN\backslash m^2$ (Including L.L & F.C.)
- Foundation Level = -2.00 m
- Columns of office building on the outer perimeter are arranged each 5.0 m and have constant dimensions $0.30 * 0.70$ m



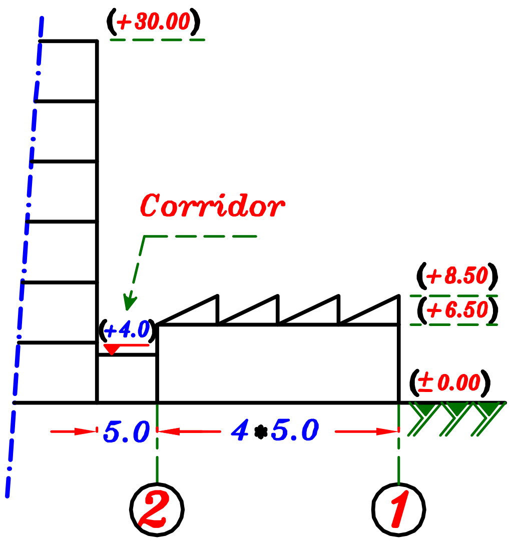
Plan



SEC. X–X

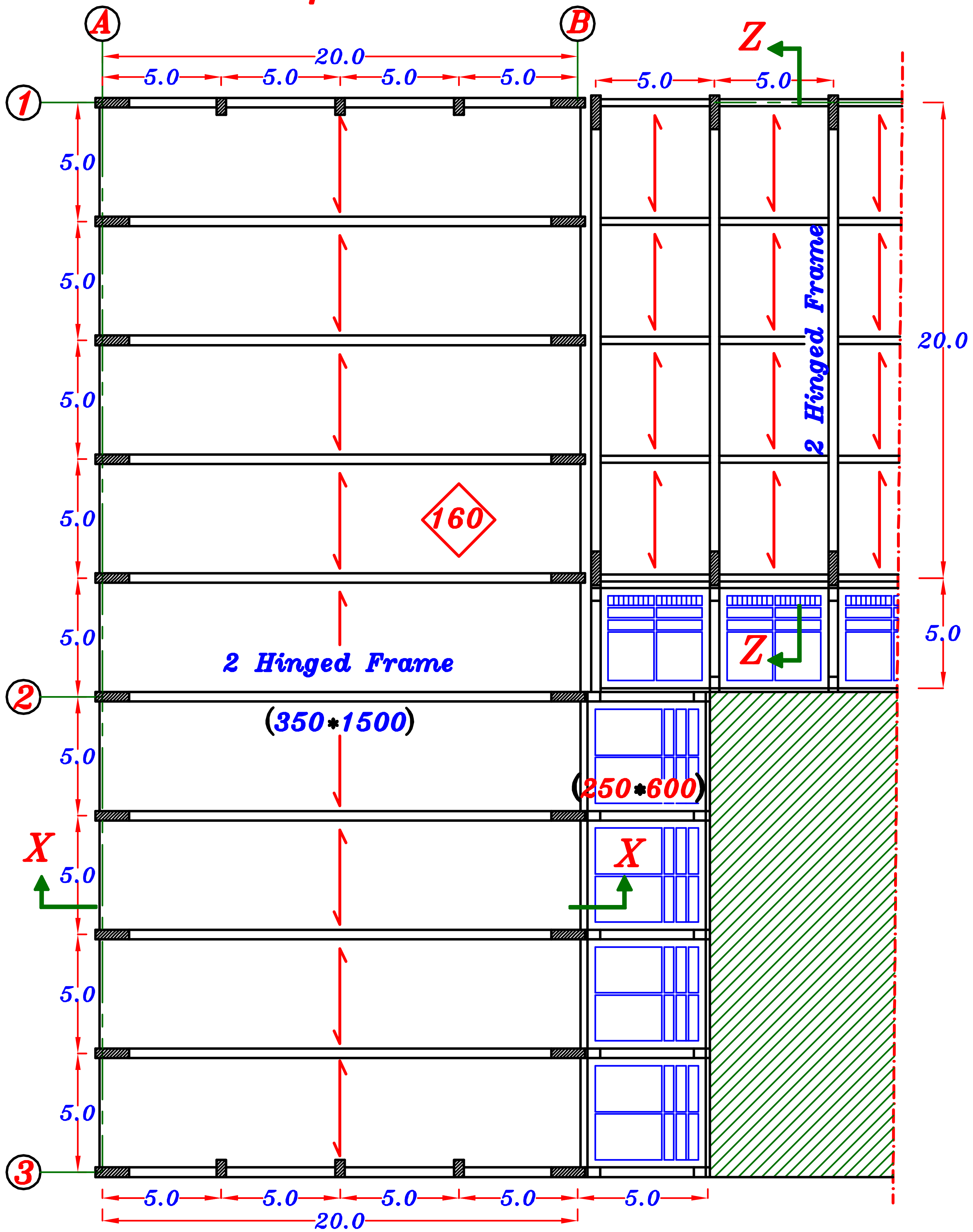


SEC. Y–Y

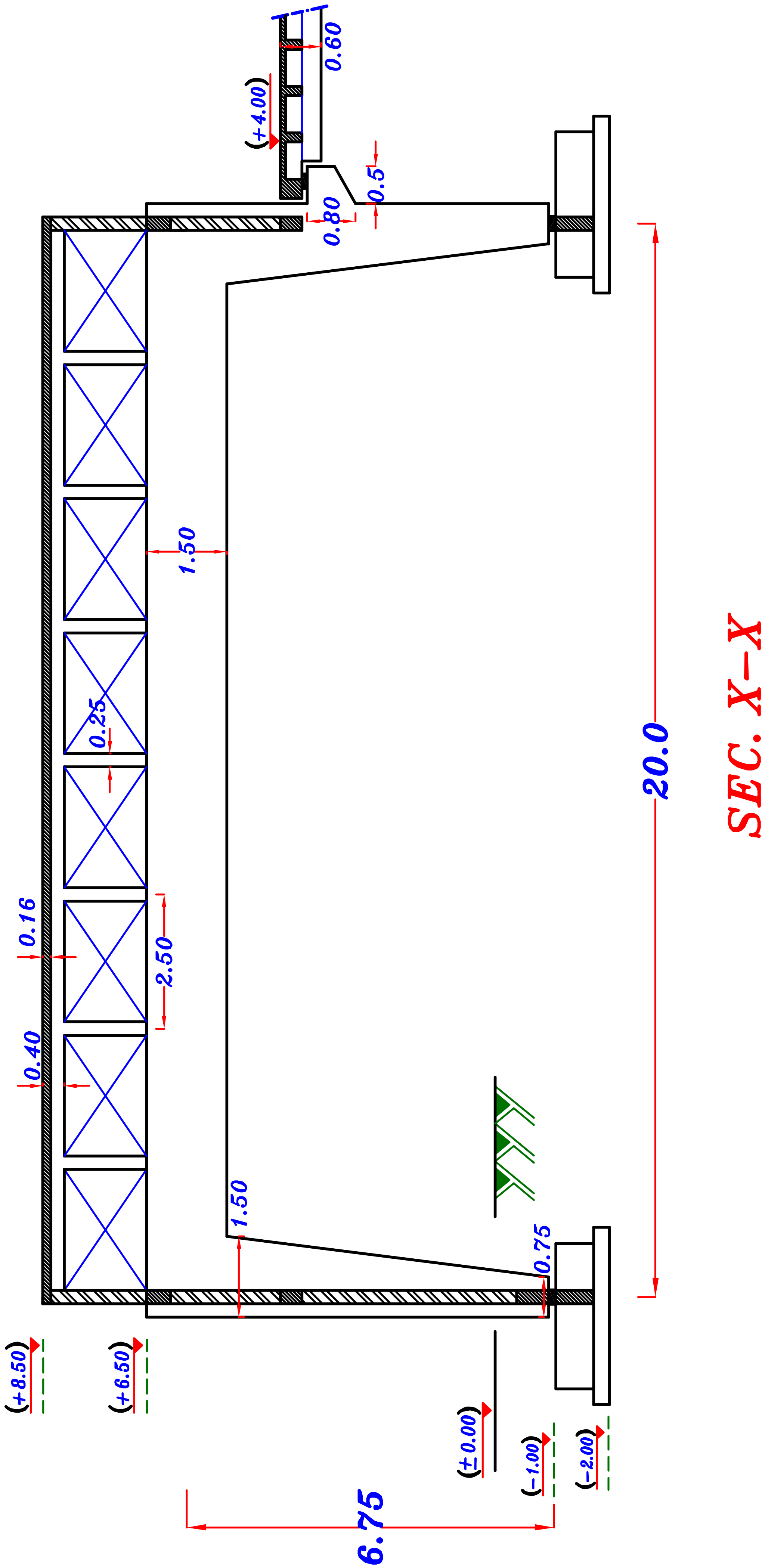


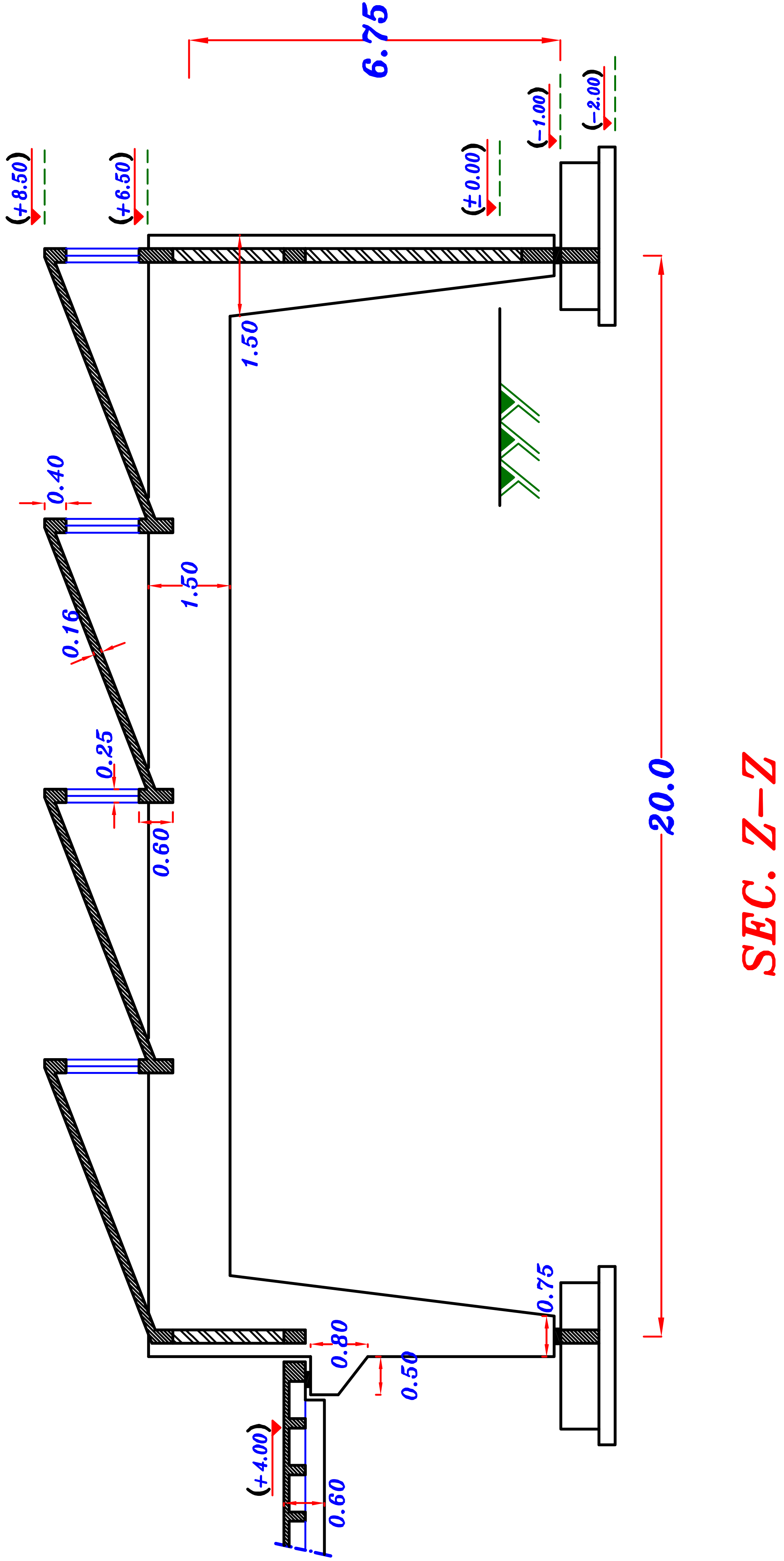
SEC. Z–Z

1 –


A
B
1
2
3
20.0
5.0
5.0
5.0
5.0
5.0
5.0
Z
Z
2 Hinged Frame
160
2 Hinged Frame
(350*1500)
(250*600)
X
X
5.0
5.0
5.0
5.0
5.0
5.0
20.0

Part Plan

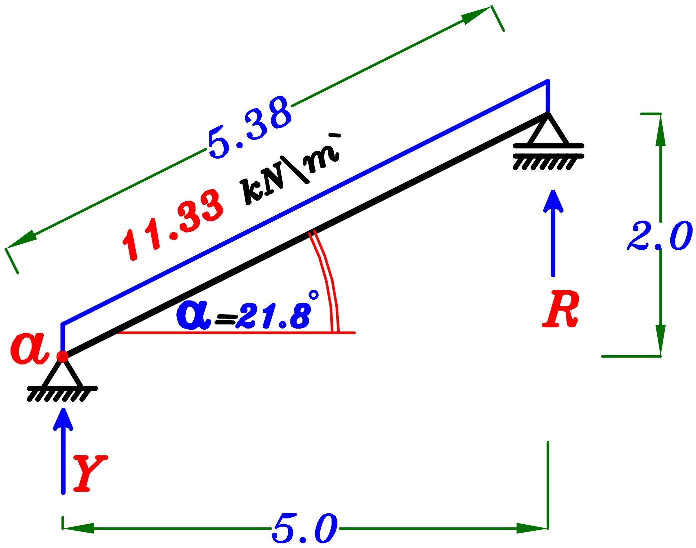

SEC. X-X
20.0
6.75
1.50
1.50
0.25
0.16
2.50
0.40
0.75
0.80
0.5
0.60
(+4.00)
(+8.50)
(+6.50)
(±0.00)
(-1.00)
(-2.00)


6.75
(+8.50)
(+6.50)
(±0.00)
(-1.00)
(-2.00)
1.50
0.40
1.50
0.16
0.25
0.60
20.0
0.75
0.80
0.50
(+4.00)
0.60

SEC. Z-Z

For an intermediate main supporting element in the region bounded by axes 2,3 & A,B

Load From saw tooth slab.



$$t_s = \frac{5380}{35} = 153.7 \ mm$$

Take $\boxed{t_s = 160 \ mm}$

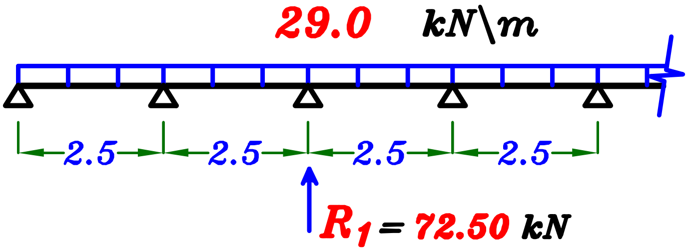
$$(w_s)_i = 1.4\,(0.16 * 25 + 1.0) + 1.6\,(1.5)\,\text{Cos}\,21.8^\circ = 9.22 \ kN\backslash m^2$$

$$\therefore \ R = Y = \frac{9.22 * 5.38}{2} = 24.80 \ kN\backslash m`$$

Loads From Ridge Beam. (250*400)

Take Distance between Posts.

= 2.50 m.

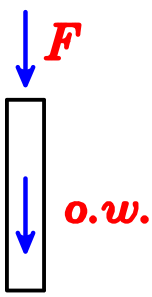


$$w = \text{O.W.}\ (\text{beam}) + R$$

$$= 4.20 + 24.80 = 29.0 \ kN\backslash m$$

$$R_1 = w * a = 29.0 * 2.5 = 72.50 \ kN$$

Loads From Post. (250*250)



$$F = \text{O.W.}\ (\text{Post}) + R_1$$

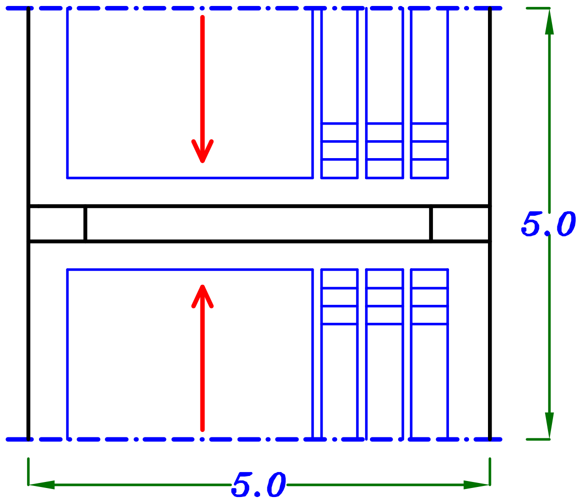
$$= 3.50 + 72.50 = 76.0 \ kN$$

Load From Hollow Blocks Slab.

$$w_s = 10.0 \ kN\backslash m^2$$

$$(w_s)_{U.L.} = 1.5 * 10.0 = 15.0 \ kN\backslash m^2$$

$$w_{rib} = \frac{w_s}{2} = 7.50 \ kN\backslash m^2$$

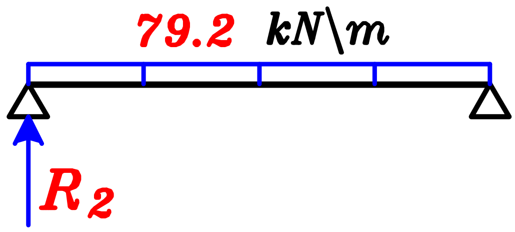


Loads on the Floating Bay

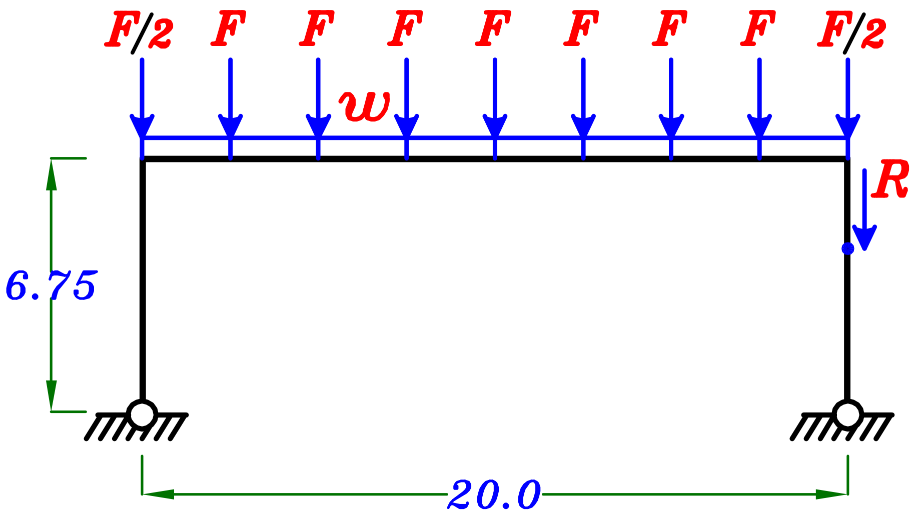
$$w = o.w. + w_s L_s = o.w. + 2 w_{rib} L_s$$

$$w = 4.20 + 2(7.50)(5.0) = 79.2 \ kN\backslash m$$

$$R_2 = \frac{wL}{2} = \frac{79.2 * 5.0}{2} = 198.0 \ kN$$



Loads on the Frame.



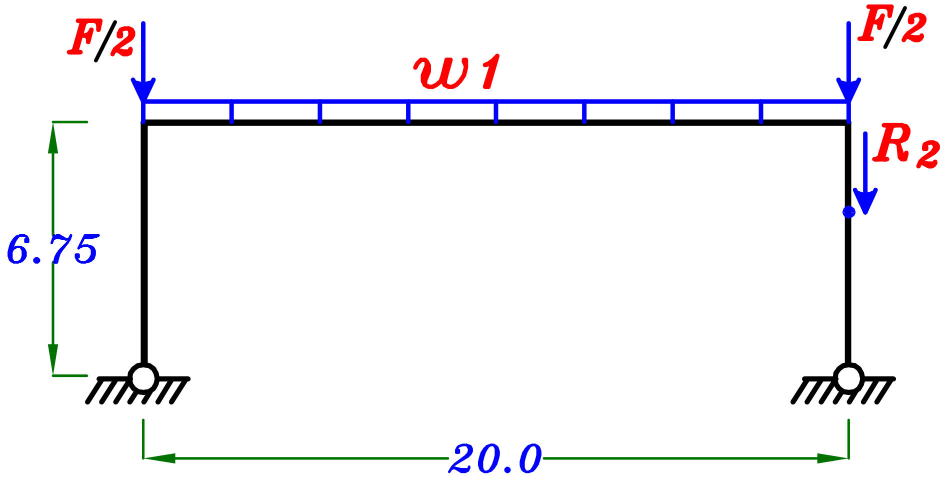
Take $o.w._{Frame}$

$$= 1.4 \, b \, t \, \gamma_c$$

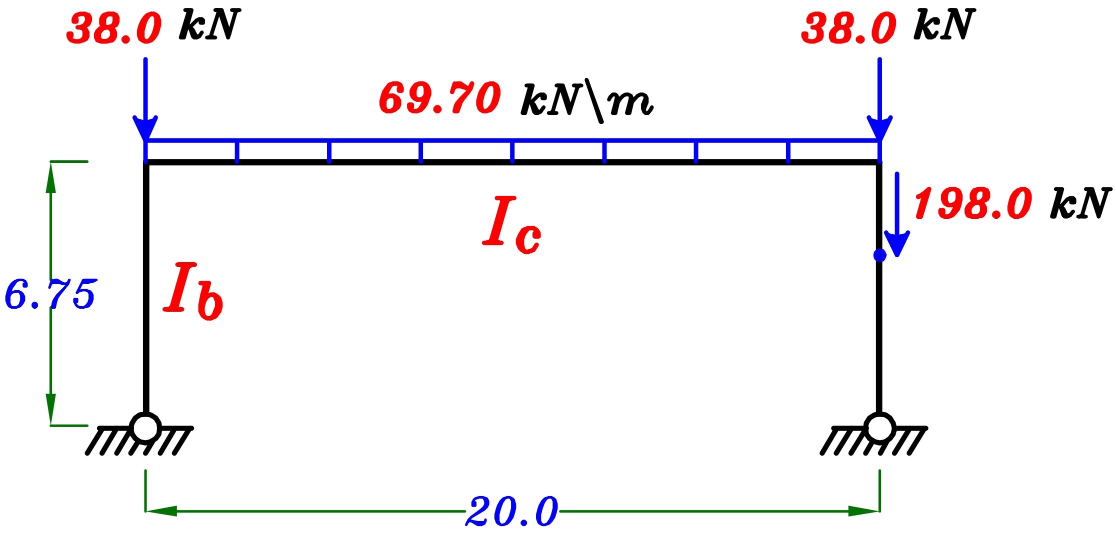
$$= 1.4(0.35 * 1.50 * 25)$$

$$= 18.3 \ kN\backslash m$$

$$w = o.w. + Y = 18.3 + 24.80 = 43.10 \ kN\backslash m$$



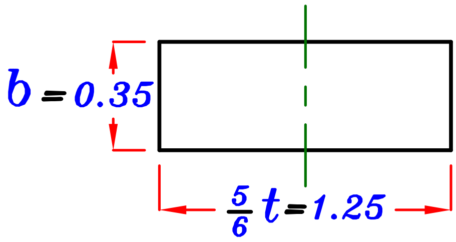
$$W1 = w + \frac{\sum P}{Span} = 43.10 + \frac{7.0 * 76.0}{20.0} = 69.70 \ kN\backslash m$$



$\underline{I_c}$

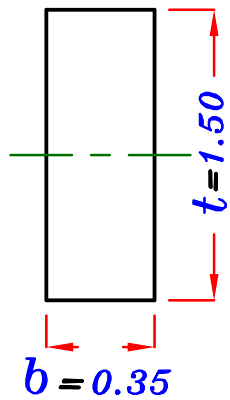
$$I_c = \frac{b\left(\frac{5}{6}t\right)^3}{12} = \frac{0.35\left(\frac{5}{6}*1.50\right)^3}{12}$$

$$= 0.0569 \ m^4$$



$\underline{I_b}$

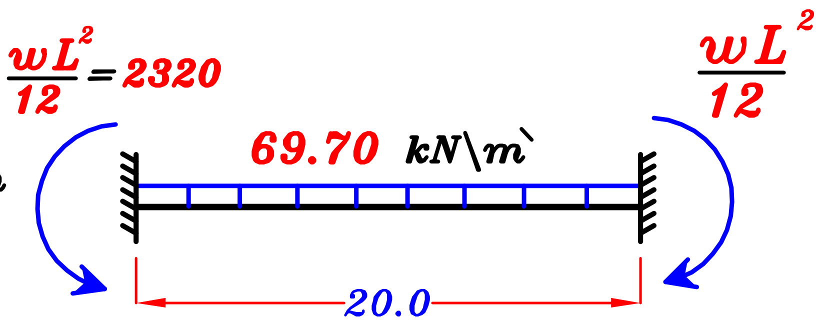
$$I_b = \frac{b*t^3}{12} = \frac{0.35(1.50)^3}{12} = 0.0984 \, m^4$$



$$\therefore \quad \boxed{I_b = 1.728 \ I_c}$$

F.E.M.

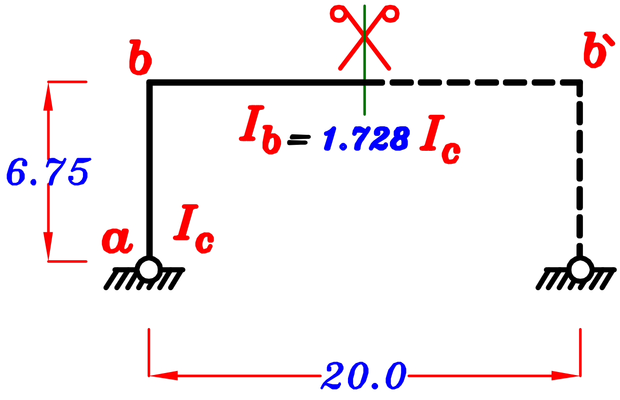
$$\frac{wL^2}{12} = \frac{69.7*(20.0)^2}{12} = 2323 \ kN.m$$



D.F. For Joint b

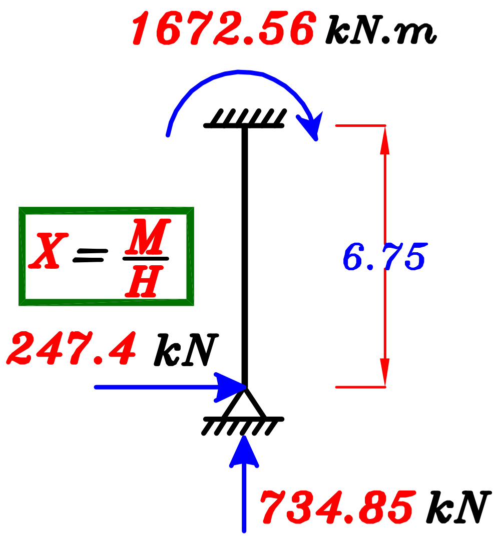
$$K_{(Col.)} = \frac{3}{4} * \frac{I_c}{h} = \frac{3}{4} * \frac{I_c}{6.75} = 0.111\ I_c$$

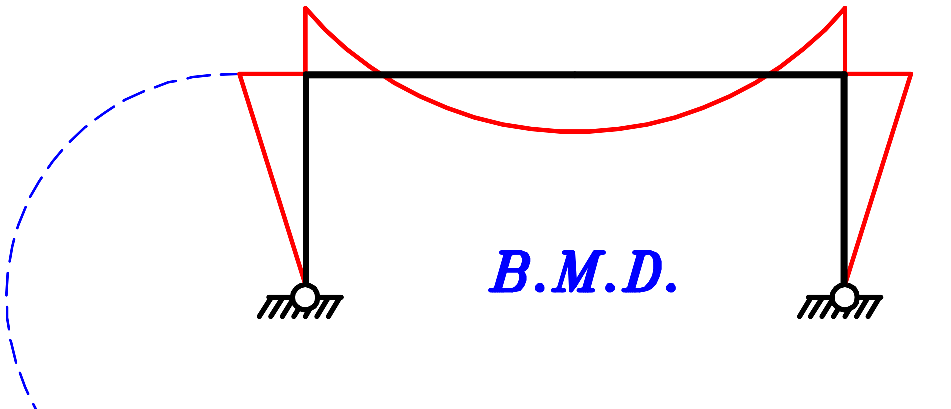
$$K_{(Beam)} = \frac{1}{2} * \frac{I_b}{L} = \frac{1}{2} * \frac{(1.728) I_c}{20.0} = 0.0432\ I_c$$



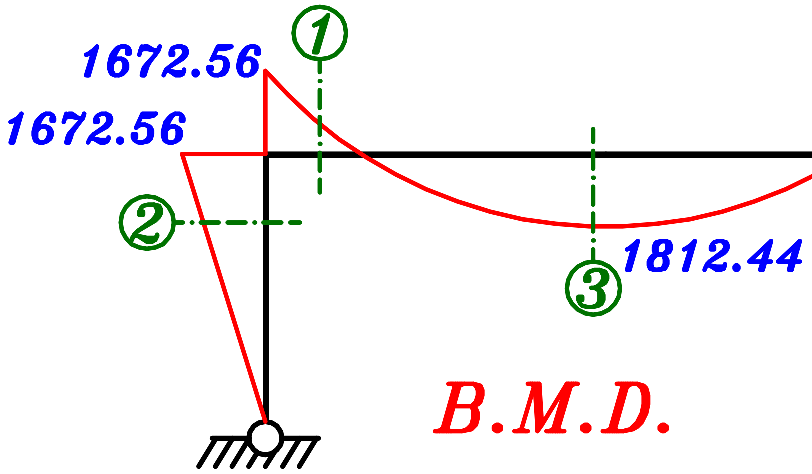
$$D.F._{(Col.)} = \frac{0.111}{0.111 + 0.0432} = 0.72$$

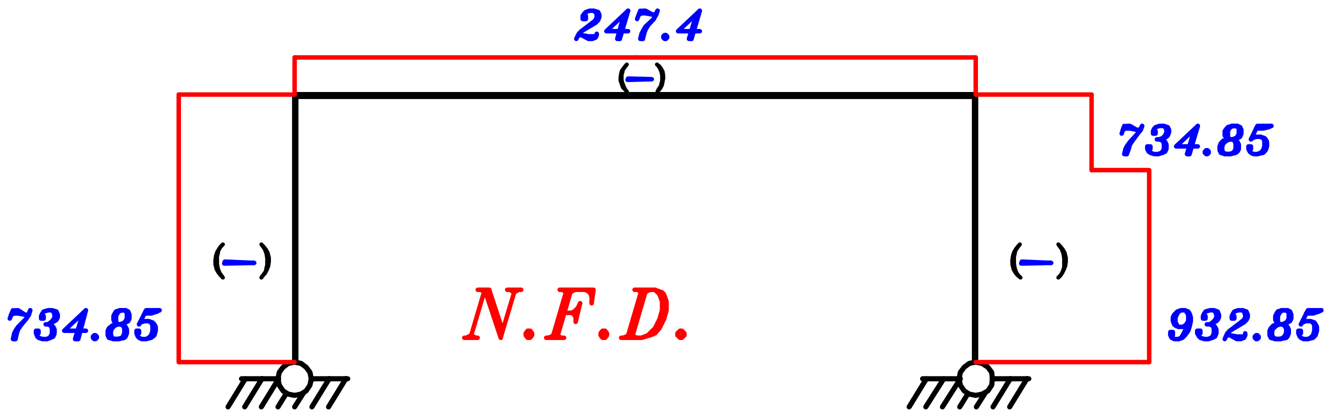
$$D.F._{(Beam)} = 1 - 0.72 = 0.28$$





$$F.E.M._{(Beam)} * D.F._{(Col.)} = 2323 * 0.72 = 1672.56$$





Design of Sections.

Take $\boxed{b = 350\ mm}$

Sec. ① R–Sec.

$M = 1672.56\ kN.m$, $P = 247.7\ kN$, $b = 0.35\ m$, $t = 1.50\ m$

Check $\dfrac{P}{F_{cu}\, b\, t} = \dfrac{247.7 * 10^3}{25 * 350 * 1500} = 0.0188 < 0.04$ (neglect P)

$$\therefore 1400 = C_1 \sqrt{\frac{1672.56 * 10^6}{30 * 350}} \longrightarrow C_1 = 3.51 \longrightarrow J = 0.78$$

$$\therefore A_s = \frac{M_{U.L.}}{J\, F_y\, d} = \frac{1672.56 * 10^6}{0.78 * 360 * 1400} = 4254.58\ mm^2$$

Check $A_{s\,min.}$ $\qquad A_{s_{req.}} = 4254.58\ mm^2$

$$\mu_{min.}\, b\, d = \left(0.225 * \frac{\sqrt{F_{cu}}}{F_y}\right) b\, d = \left(0.225 * \frac{\sqrt{25}}{360}\right) 350 * 1400 = 1677.4\ mm^2$$

$\therefore A_{s_{req.}} > \mu_{min.}\, b\, d$ $\quad\therefore$ Take $A_s = A_{s_{req.}} = 4254.58\ mm^2$ $\quad$ $9 \phi 25$

$$\therefore n = \frac{b - 25}{\phi + 25} = \frac{350 - 25}{25 + 25} = 6.50 = 6.0 \text{ bars}$$

Sec. ② R–Sec.

Neglect effect of Buckling.

$M = 1672.56\ kN.m$, $P = 734.85\ kN$

Check $\dfrac{P}{F_{cu}\, b\, t} = \dfrac{734.85 * 10^3}{30 * 350 * 1500} = 0.0466 > 0.04$ (Don't neglect P)

$$e = \frac{M}{P} = \frac{1672.56}{734.85} = 2.276\ m \quad \therefore \frac{e}{t} = \frac{2.276}{1.50} = 1.51 > 0.5 \xrightarrow{use} e_s$$

$$e_s = e + \frac{t}{2} - c = 2.276 + \frac{1.5}{2} - 0.1 = 2.926\ m$$

$$M_s = P * e_s = 734.85 * 2.926 = 2150.17\ kN.m$$

$$\therefore 1400 = C_1 \sqrt{\frac{2150.17 * 10^6}{30 * 350}} \longrightarrow C_1 = 3.09 \longrightarrow J = 0.752$$

$$\therefore A_s = \frac{M_s}{J\, F_y\, d} - \frac{P_{U.L.}}{(F_y \backslash \gamma_s)} = \frac{2150.17 * 10^6}{0.752 * 360 * 1400} - \frac{734.85 * 10^3}{(360 \backslash 1.15)}$$

$$= 3325.71 \text{ mm}^2$$

Check $A_{s\,min.}$ $\quad A_{s_{req.}} = 3325.71 \text{ mm}^2$

$$\mu_{min.}\, b\, d = \left(0.225 * \frac{\sqrt{F_{cu}}}{F_y}\right) b\, d = \left(0.225 * \frac{\sqrt{30}}{360}\right) 350 * 1400 = 1677.4 \text{ mm}^2$$

$$\therefore A_{s_{req.}} > \mu_{min.}\, b\, d \quad \therefore \text{Take } A_s = A_{s_{req.}} = 3325.71 \text{ mm}^2 \quad 7 \phi 25$$

Sec. 3 R-Sec.

$$M = 1810 \text{ kN.m}, \quad P = 247.4 \text{ kN}, \quad b = 0.35 \text{ m}, \quad t = 1.50 \text{ m}$$

$$\text{Check} \quad \frac{P}{F_{cu}\, b\, t} = \frac{247.4 * 10^3}{30 * 350 * 1500} = 0.015 < 0.04 \quad (\text{neglect } P)$$

$$\therefore 1400 = C_1 \sqrt{\frac{1810 * 10^6}{30 * 350}} \longrightarrow C_1 = 3.37 \longrightarrow J = 0.774$$

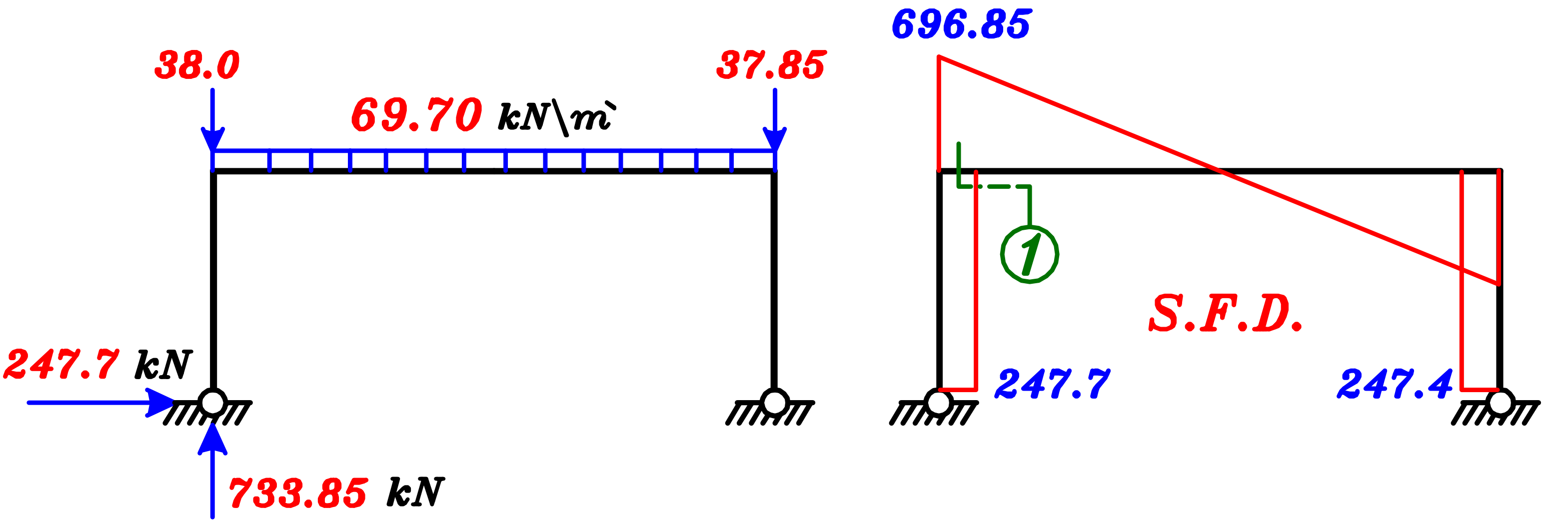
$$\therefore A_s = \frac{M_{U.L.}}{J\, F_y\, d} = \frac{1810 * 10^6}{0.774 * 360 * 1400} = 4640 \text{ mm}^2$$

Check $A_{s\,min.}$ $\quad A_{s_{req.}} = 4640 \text{ mm}^2$

$$\mu_{min.}\, b\, d = \left(0.225 * \frac{\sqrt{F_{cu}}}{F_y}\right) b\, d = \left(0.225 * \frac{\sqrt{30}}{360}\right) 350 * 1400 = 1677.4 \text{ mm}^2$$

$$\therefore A_{s_{req.}} > \mu_{min.}\, b\, d \quad \therefore \text{Take } A_s = A_{s_{req.}} = 4640 \text{ mm}^2 \quad 10 \phi 25$$

Check Shear.



Sec. 1

$$q_{cu} = (0.24)\sqrt{\frac{30}{1.50}} = 1.07 \quad N\backslash mm^2$$

$$q_{u_{max}} = (0.70)\sqrt{\frac{30}{1.50}} = 3.13 \quad N\backslash mm^2$$

$$q_u = \frac{Q_{max}}{b\,d} = \frac{696.85 * 10^3}{350 * 1400} = 1.422\, N\backslash mm^2$$

$\therefore\ q_{cu} < q_U < q_{max.}$ $\therefore$ We need Stirrups more Than $5\phi 8\backslash m$`

$\therefore$ Use $$q_S = q_u - \frac{q_{cu}}{2} = \frac{n A_s (F_y\backslash \gamma_s)}{b\ \ S}$$

* Take $n = 2$, $\phi\ 8 \longrightarrow A_s = 50.3\ \ mm^2$

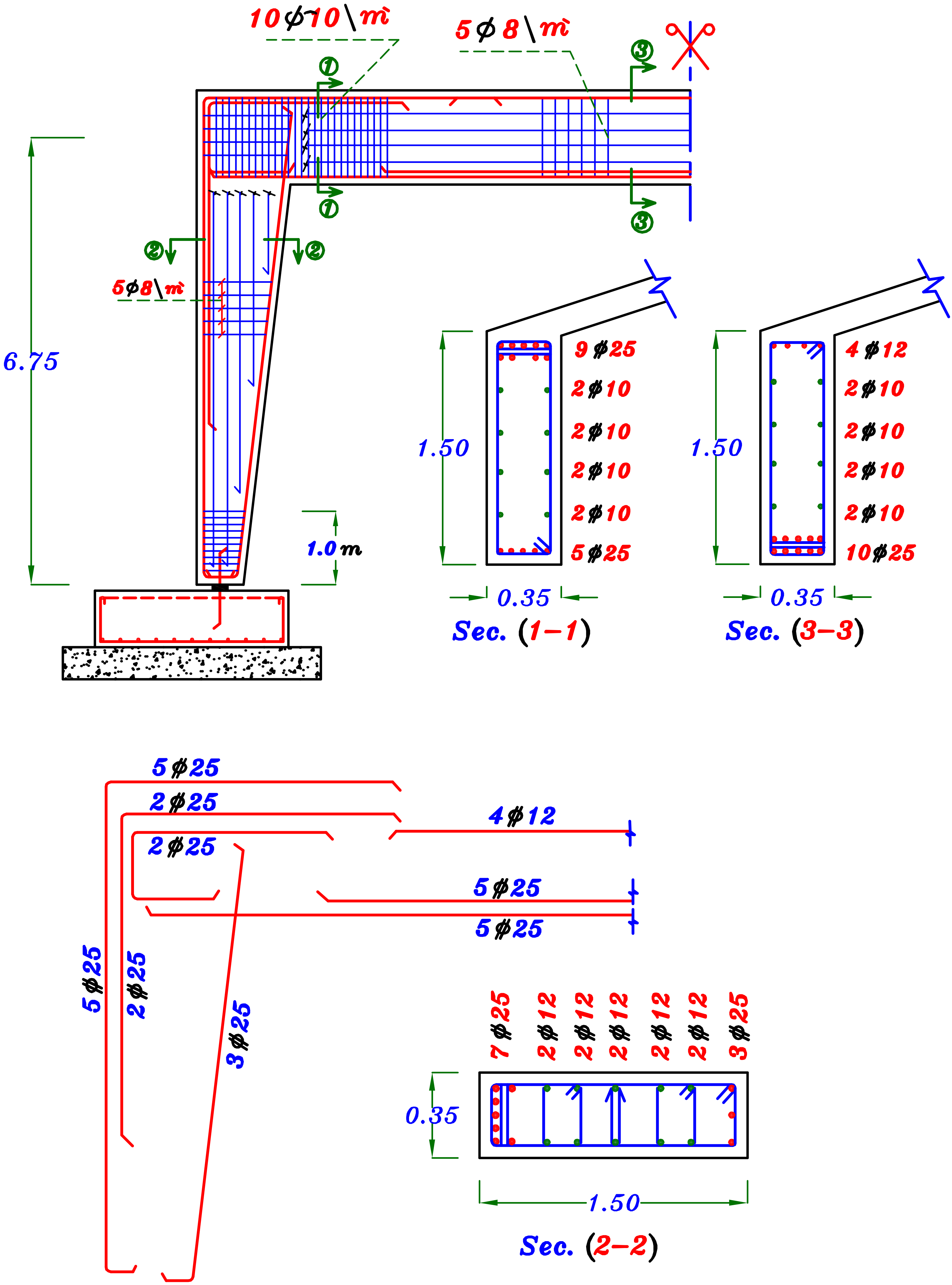
$$1.422 - \frac{1.07}{2} = \frac{2 * 50.3\ (240\backslash 1.15)}{350 * S} \longrightarrow S = 67.62\ mm < 100\ mm$$

* Take $n = 2$, $\phi\ 10 \longrightarrow A_s = 78.5\ \ mm^2$

$$1.422 - \frac{1.07}{2} = \frac{2 * 78.5\ (240\backslash 1.15)}{350 * S} \longrightarrow S = 105.52\, mm > 100\ mm \therefore\ o.k.$$

$\therefore$ No. of stirrups\m` $= \frac{1000}{S} = \frac{1000}{105.52} = 9.48 = 10\backslash m$`

$\therefore$ Use Stirrups $\boxed{10\,\phi 10\backslash m`}$ 2 branches



10ϕ10\m'
5ϕ8\m'
①
②
③
5ϕ8\m'
6.75
1.0 m
9ϕ25
2ϕ10
2ϕ10
2ϕ10
2ϕ10
5ϕ25
1.50
0.35
Sec. (1–1)
4ϕ12
2ϕ10
2ϕ10
2ϕ10
2ϕ10
10ϕ25
1.50
0.35
Sec. (3–3)
5ϕ25
2ϕ25
2ϕ25
4ϕ12
5ϕ25
5ϕ25
5ϕ25
2ϕ25
3ϕ25
7ϕ25
2ϕ12
2ϕ12
2ϕ12
2ϕ12
2ϕ12
3ϕ25
0.35
1.50
Sec. (2–2)

Example.

$F_{cu.} = 25 \quad N\backslash mm^2$

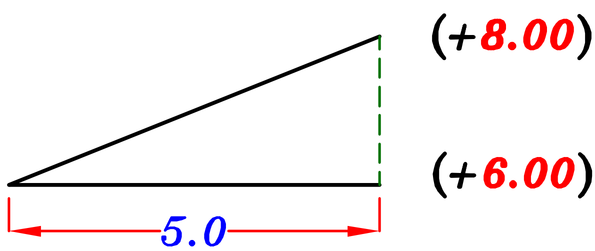
$F_y = 360 \quad N\backslash mm^2$

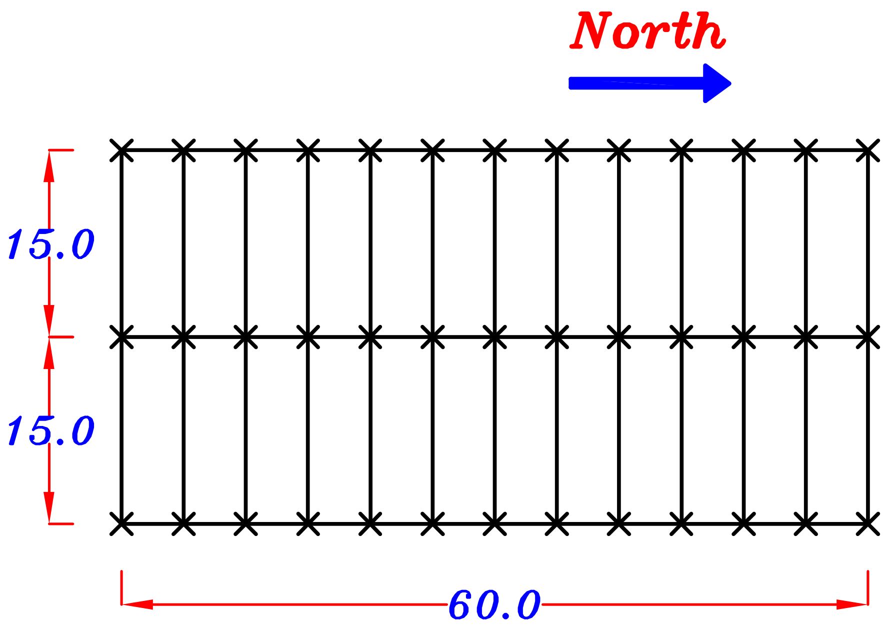
$L.L. = 1.0 \quad kN\backslash m^2$

$F.C. = 1.0 \quad kN\backslash m^2$

$Spacing = 5.0\ m$

$t_s = 160\ mm$





Req.

① Choose a convient system and draw concrete dimensions in elevation & plan.

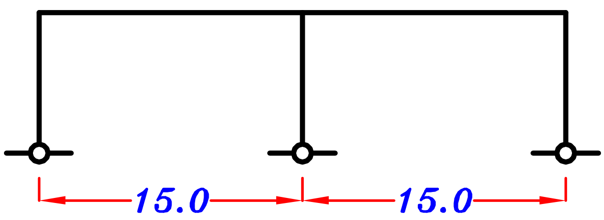
② Design slabs and draw its RFT. in plan.

③ Design the main supporting element.

④ Draw the RFT. of main supporting element in elevation & cross sections.

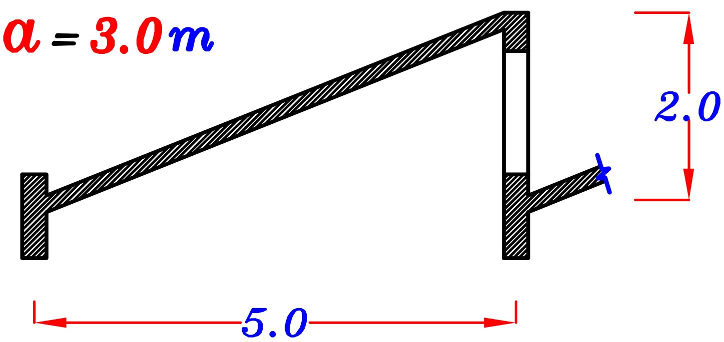
Solution.

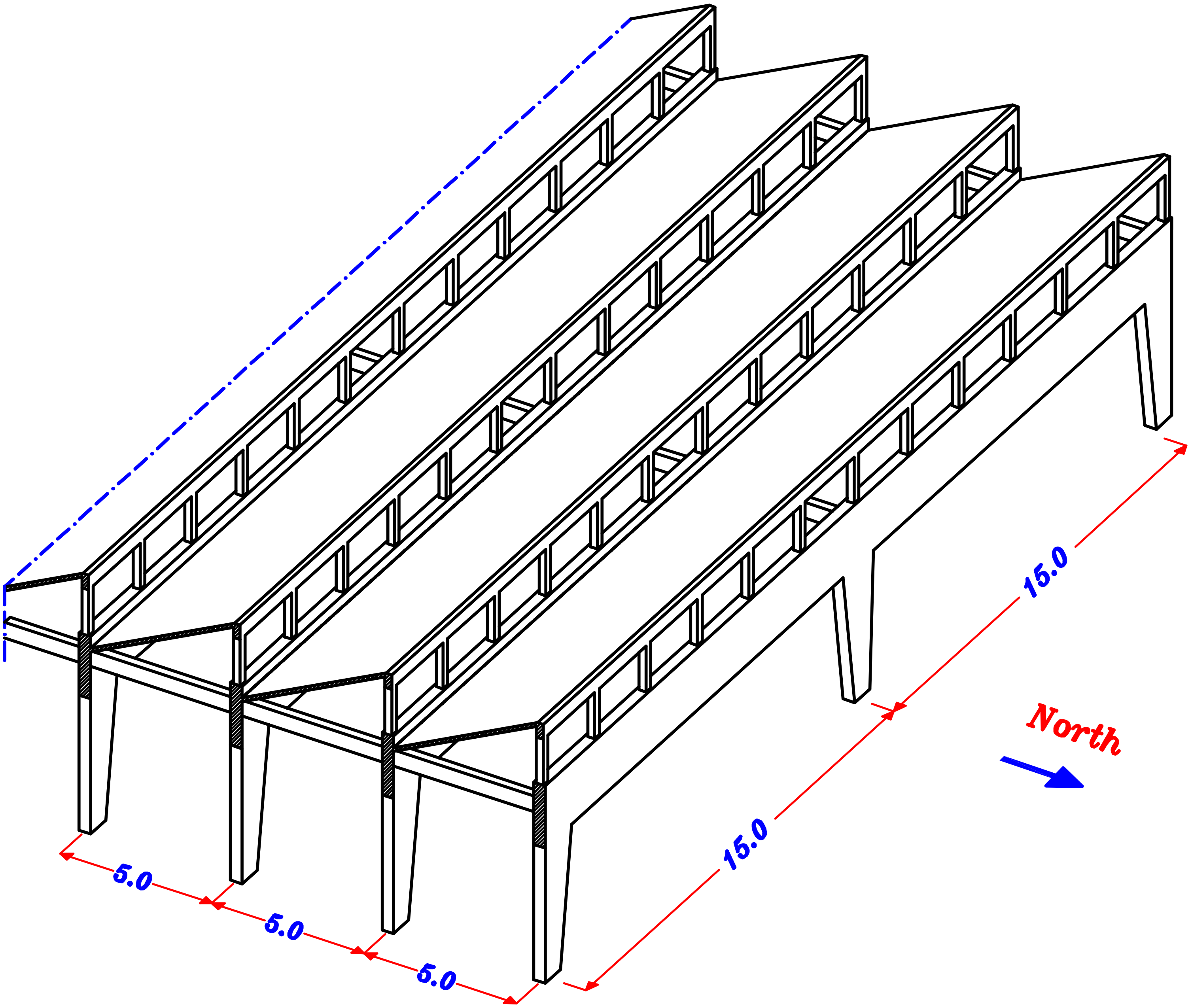
Choose continous hinged Frame.

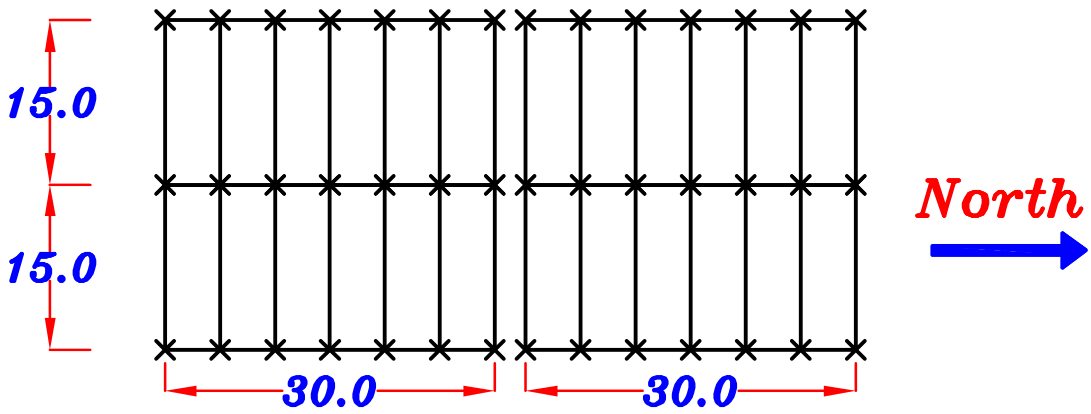


Choose saw tooth slab type. Solid slab

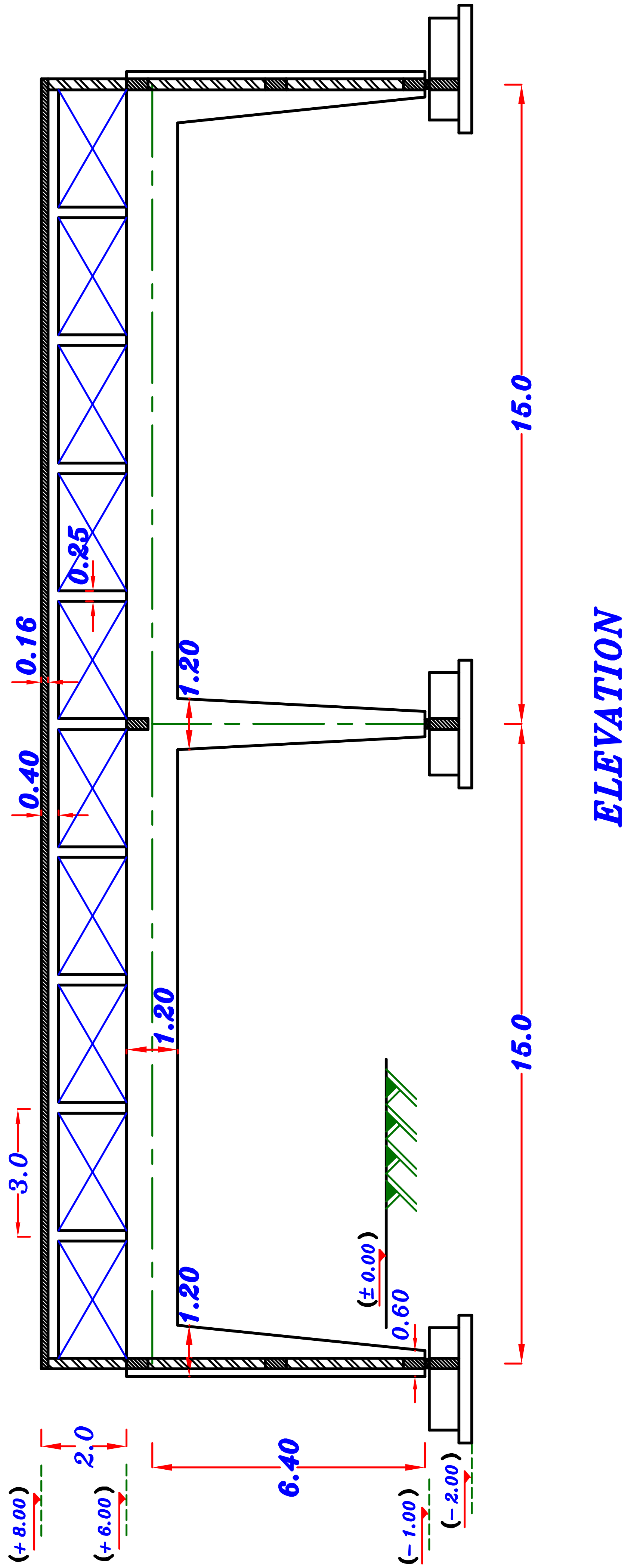
Take spacing between posts $a = 3.0\, m$

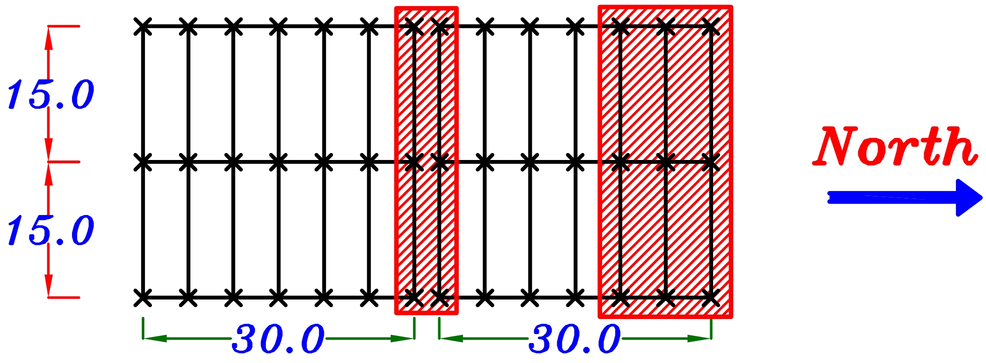


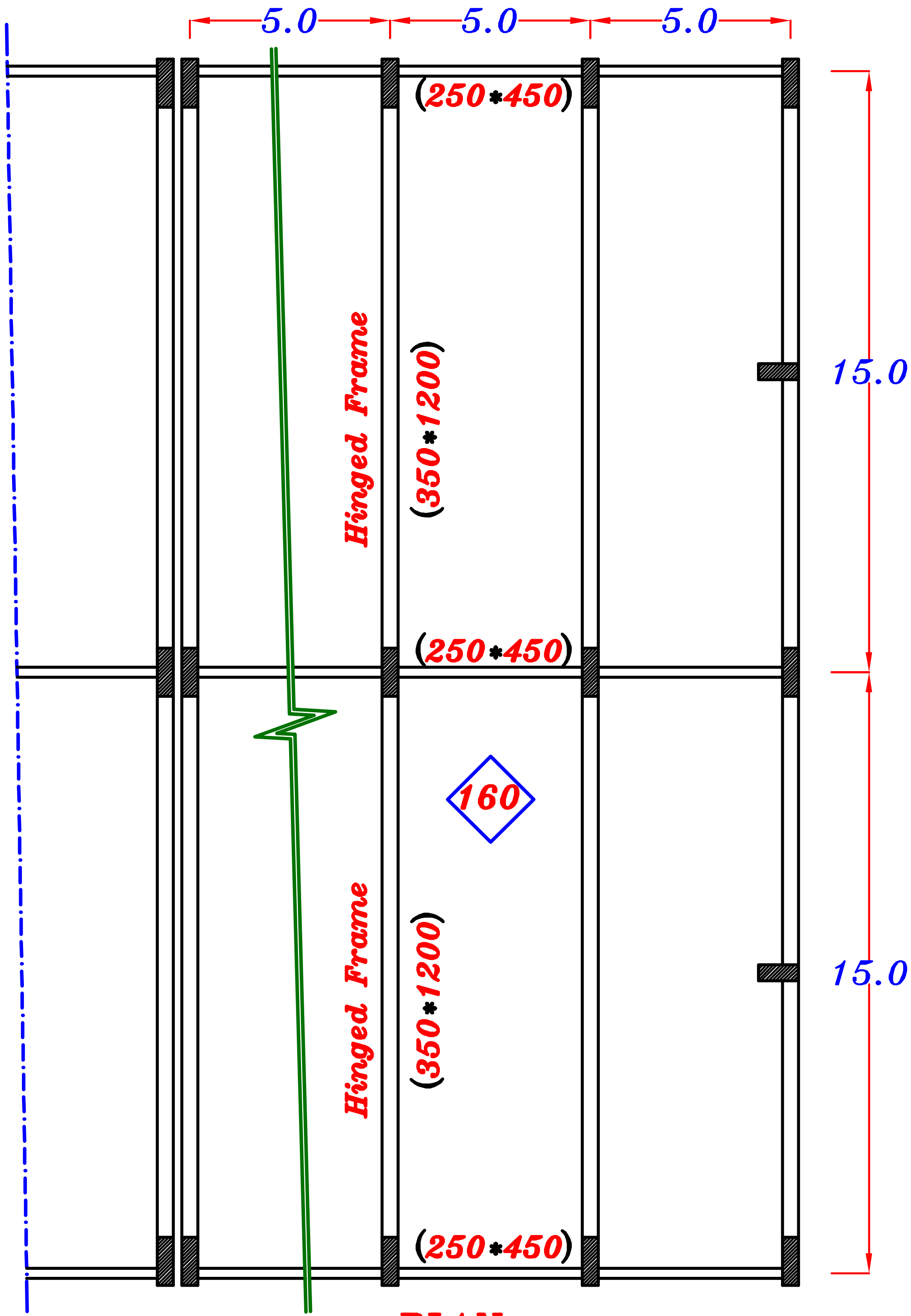




Key Plan


ELEVATION
15.0
15.0
0.16
0.40
0.25
1.20
1.20
1.20
3.0
2.0
6.40
0.60
(± 0.00)
(+ 8.00)
(+ 6.00)
(− 1.00)
(− 2.00)


15.0
15.0
30.0
30.0
North

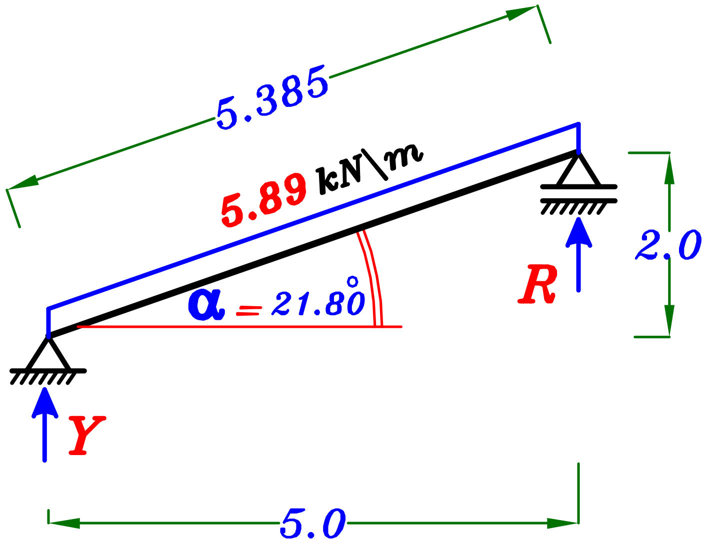

5.0
5.0
5.0
(250*450)
Hinged Frame
(350*1200)
15.0
(250*450)
160
Hinged Frame
(350*1200)
15.0
(250*450)

PLAN

Slabs.

Take $\boxed{t_s = 160\ mm}$

As given in data.



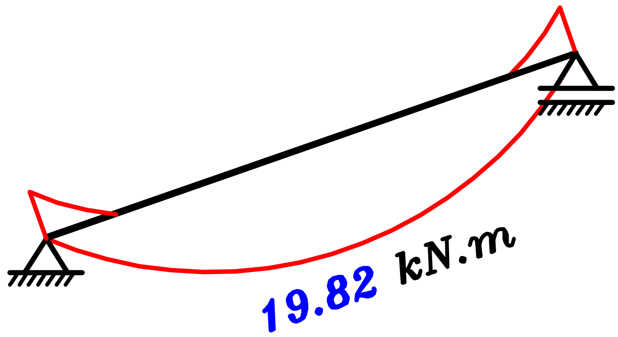
$$(w_s)_i = 1.4\,(0.16 * 25 + 1.0) + 1.6\,(1.0)\,Cos\,21.80^\circ = 5.89\ kN\backslash m^2$$

$$R = Y = \frac{wL`}{2} = \frac{5.89 * 5.385}{2} = 15.86\ kN$$

Design of slab.

$$M = \frac{w\,L\,L`}{8} = \frac{5.89 * 5.0 * 5.385}{8}$$

$$= 19.82\ kN.m$$



$$t_s = 160\ mm\ ,\ d = 160 - 20 = 140\ mm$$

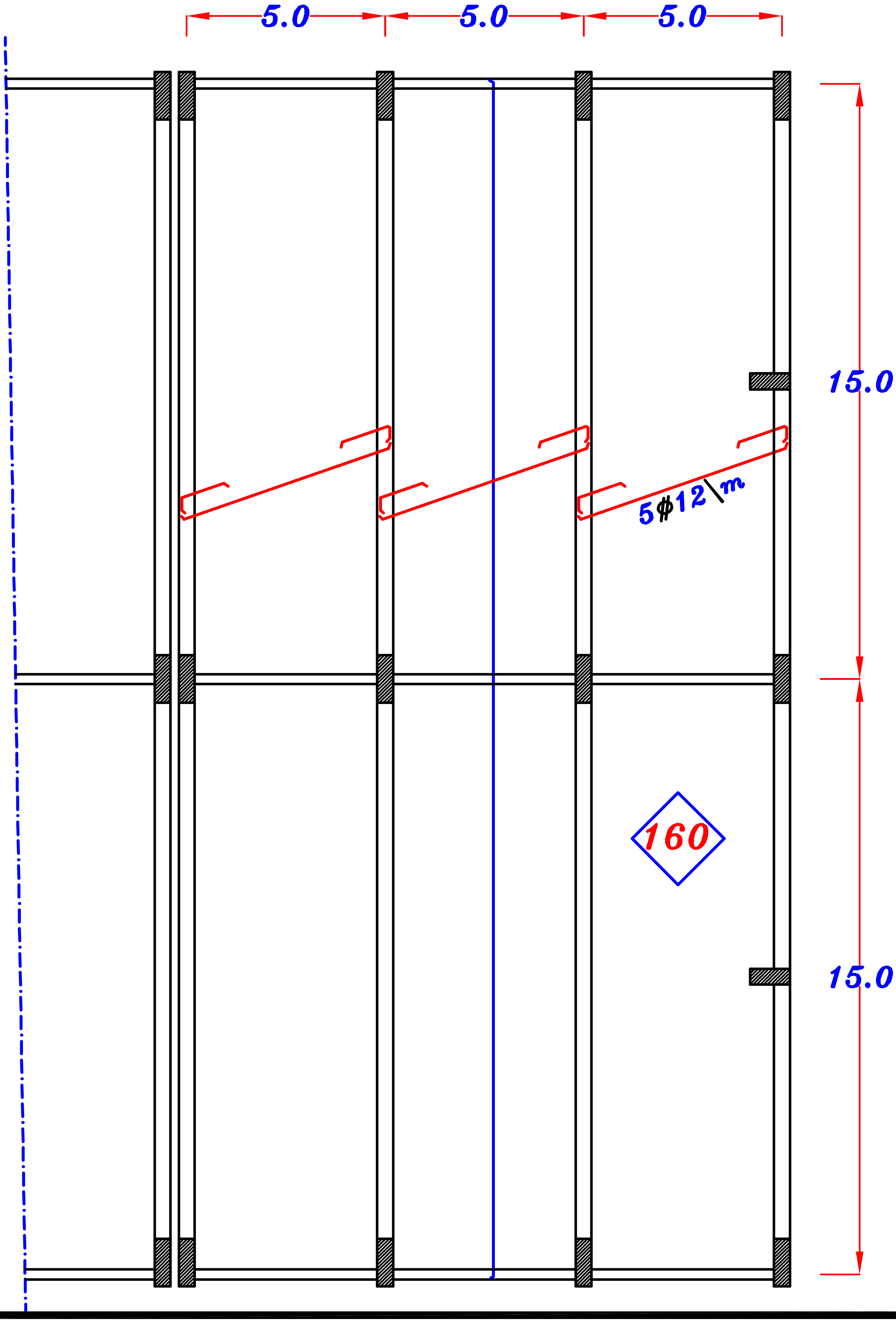
$$140 = C_1\sqrt{\frac{19.82 * 10^6}{25 * 1000}}$$

$$\longrightarrow C_1 = 4.97 \longrightarrow J = 0.826$$

$$A_s = \frac{19.82 * 10^6}{0.826 * 360 * 140} = 476.1\ mm^2\backslash m$$

5 ϕ 12 \m

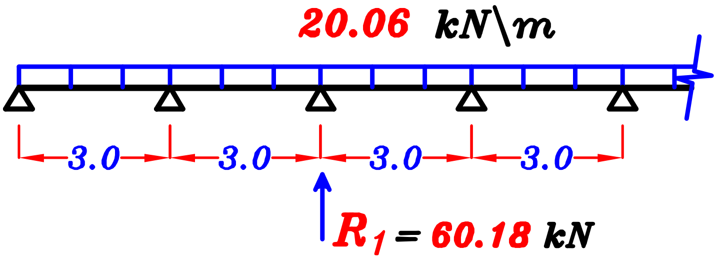
RFT. of the Slabs.



Loads From Ridge Beam. (250*400)

Take Distance between Posts.

$= 3.0 \; m.$

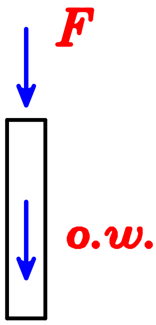


$w = O.W.\,(beam) + R$

$= 4.20 + 15.86 = 20.06 \; kN\backslash m$

$R_1 = w * a = 20.06 * 3.0 = 60.18 \; kN$

Loads From Post. (250*250)



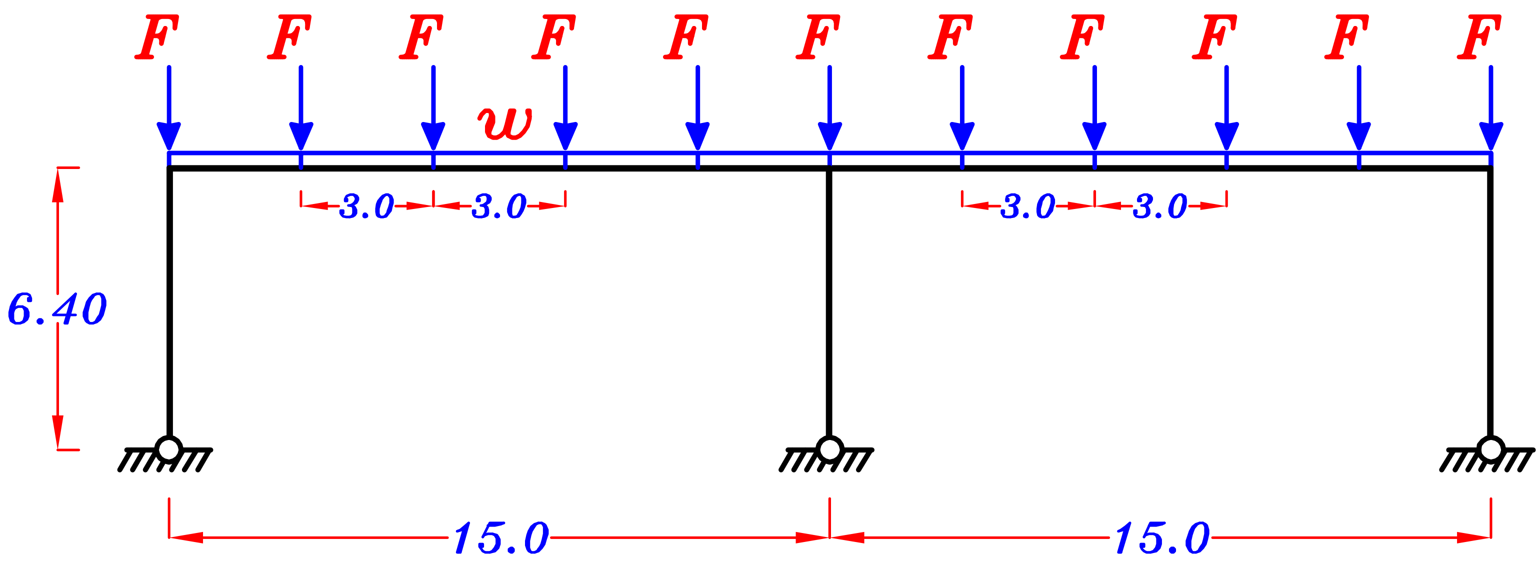
$F = O.W.\,(Post) + R_1$

$= 3.50 + 60.18 = 63.68 \; kN$

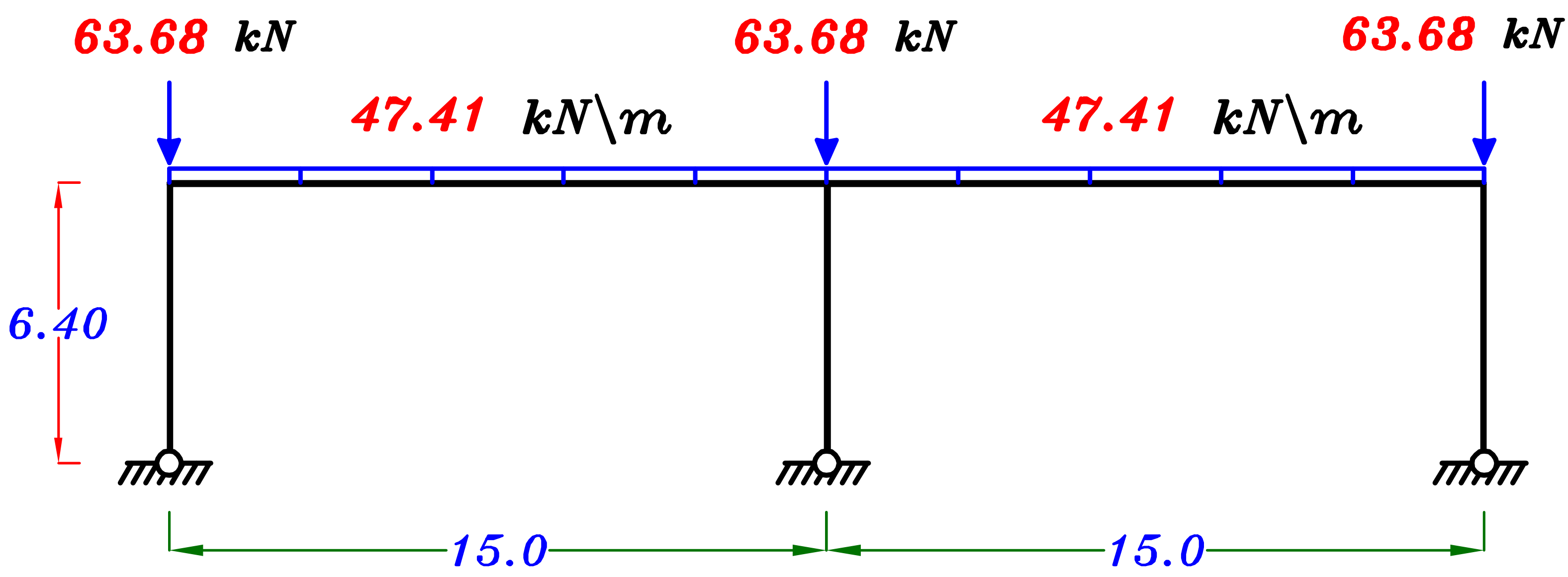
Loads on Frame. (350*1200)

$o.w. = 1.4 \, b \, t \, \gamma_c = 1.4 * 0.35 * 1.20 * 25 = 14.70 \; kN\backslash m$

$w = o.w. + Y = 14.70 + 15.86 = 30.56 \; kN\backslash m$

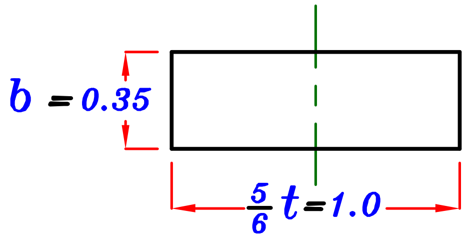


$$w_1 = w + \frac{\sum F}{Span} = 30.56 + \frac{4.0 * 63.68}{15.0} = 47.41 \; kN\backslash m$$

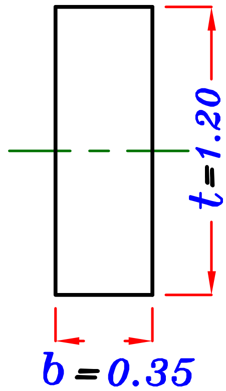


Solve the Frame using Moment Distribution.

$$I_c = \frac{b\left(\frac{5}{6}t\right)^3}{12} = \frac{0.35\left(\frac{5}{6}*1.2\right)^3}{12} = 0.0291\ m^4$$

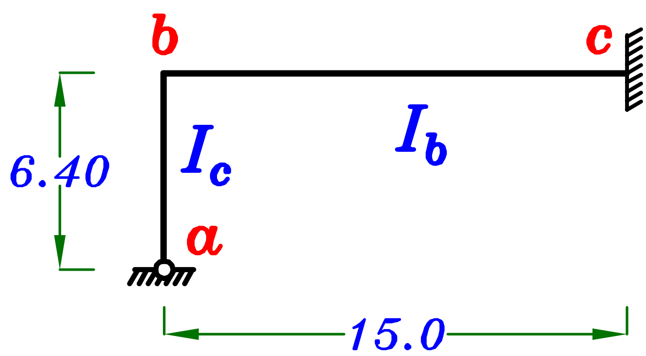


$$I_b = \frac{b*t^3}{12} = \frac{0.35\ (1.20)^3}{12} = 0.0504\ m^4$$



$$\therefore \quad \boxed{I_b = 1.732\ I_c}$$

D.F. For Joint b



$$K_{(Col.)} = \frac{3}{4}\ \frac{I_c}{h} = \frac{3}{4} * \frac{I_c}{6.4} = 0.117\ I_c$$

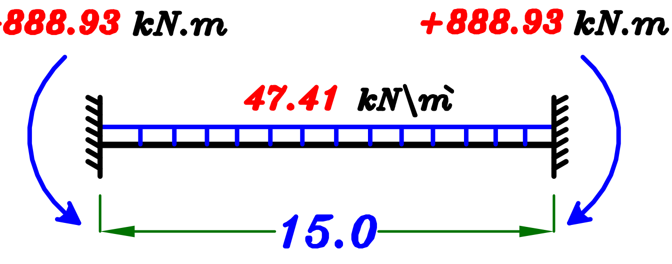
$$K_{(Beam)} = \frac{I_b}{L} = \frac{1.732\ I_c}{15} = 0.115\ I_c$$

$$D.F._{(Col.)} = \frac{0.117}{0.117 + 0.115} = 0.503$$

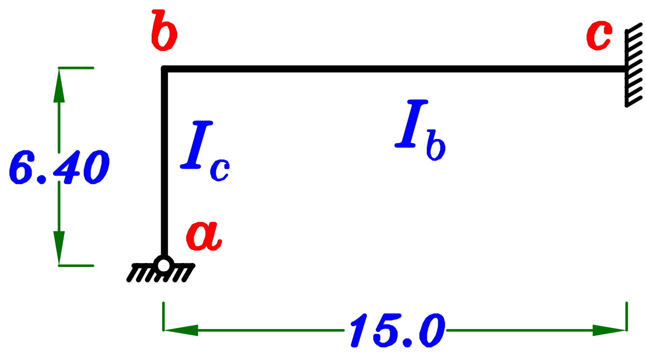
$$D.F._{(Beam)} = 1 - 0.503 = 0.497$$

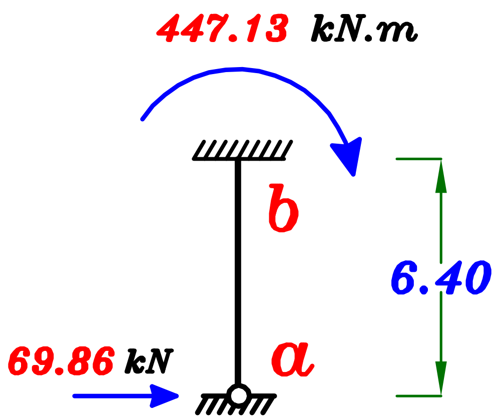
F.E.M.

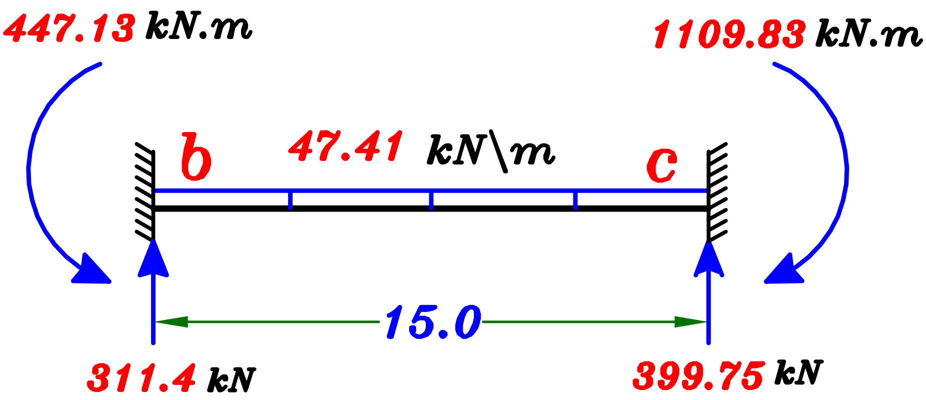
$$M = \frac{wL^2}{12} = \frac{47.41 * (15)^2}{12} = 888.93 \text{ kN.m}$$

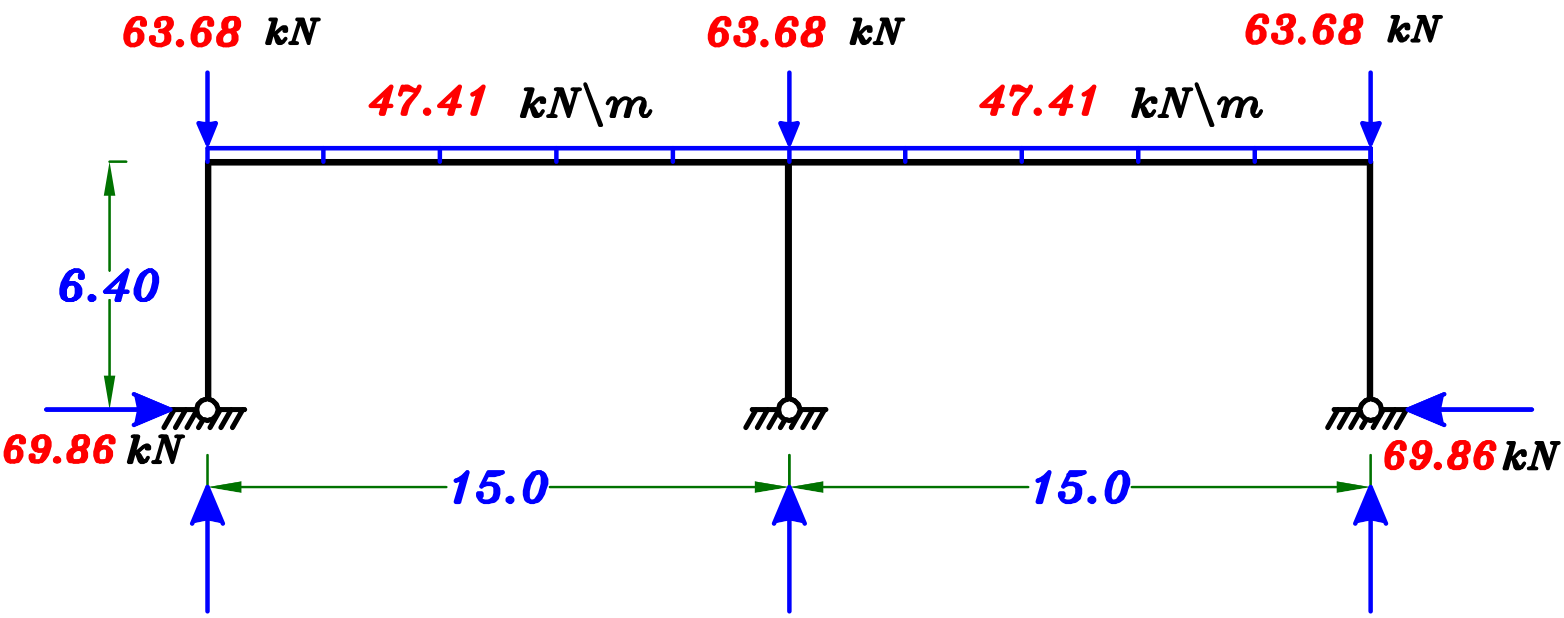


Joints	b		c
members	b-a	b-c	c-b
D.F.	0.503	0.497	—
F.E.M.	—	-888.93	+888.93
B.M.	+447.13	+441.8	—
C.O.M	—	—	+220.9
B.M.	—	—	—
M_F	+447.13	-447.13	+1109.83





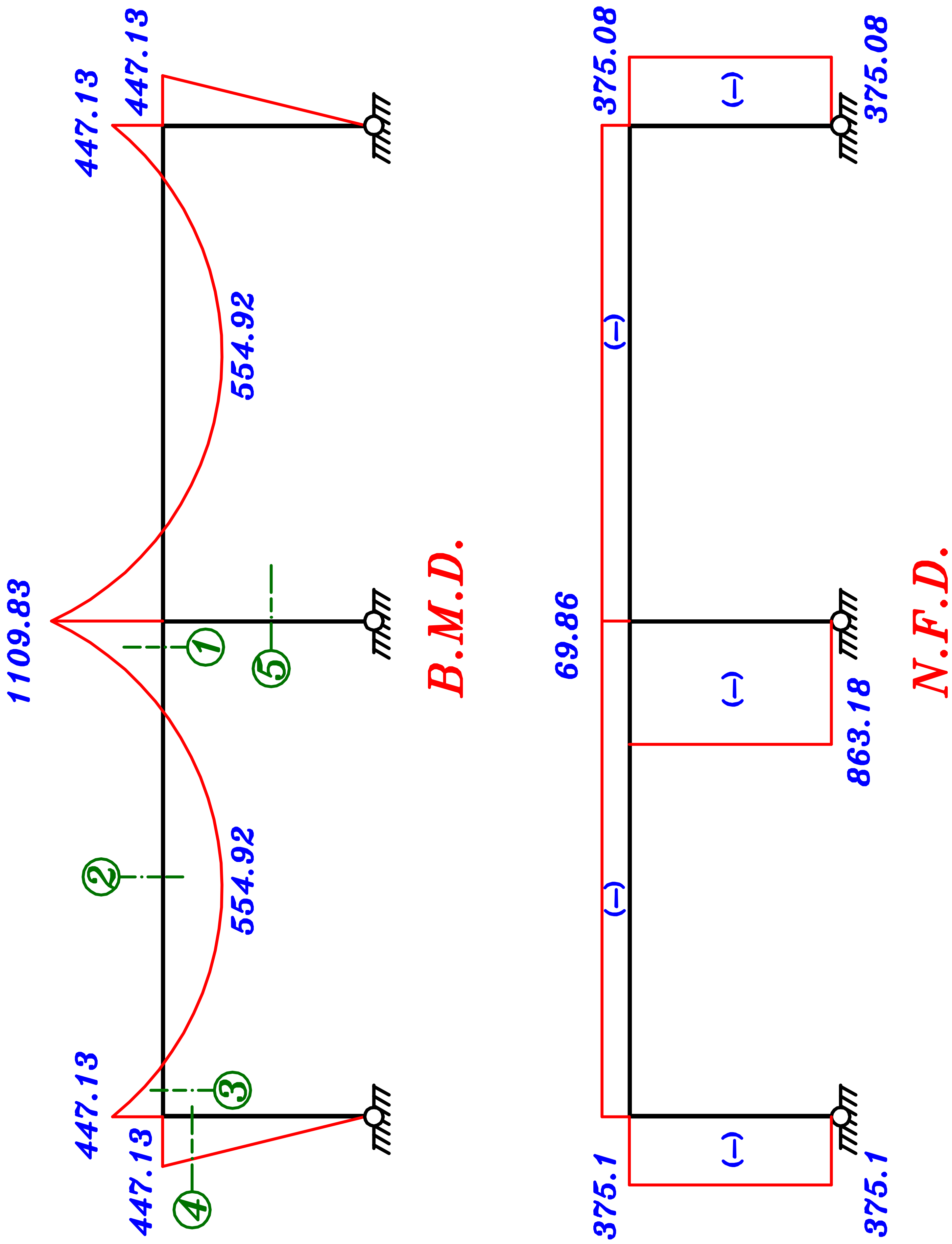




311.4 + 63.68 = 375.08 kN

2 * 399.75 + 63.68 = 863.18 kN

311.4 + 63.68 = 375.08 kN


447.13
447.13
1109.83
554.92
554.92
447.13
447.13
1
2
3
4
5
B.M.D.
375.08
375.08
69.86
863.18
375.1
375.1
(–)
(–)
(–)
(–)
(–)
N.F.D.

Design of Sections.

Sec. ① R–Sec.

$M = 1109.83$ kN.m , $P = 69.86$ kN , $b = 0.35$ m , $t = 1.20$ m

Check $\frac{P}{F_{cu}\, b\, t} = \frac{69.86 * 10^3}{25 * 350 * 1200} = 0.0066 < 0.04$ (neglect P)

$\therefore 1100 = C_1 \sqrt{\frac{1109.83 * 10^6}{25 * 350}} \longrightarrow C_1 = 3.08 \longrightarrow J = 0.78$

$$\therefore A_s = \frac{M_{U.L.}}{J\, F_y\, d} = \frac{1109.83 * 10^6}{0.78 * 360 * 1100} = 3593.0 \text{ mm}^2$$

Check $A_{s\,min.}$ $\qquad A_{s_{req.}} = 3593.0 \text{ mm}^2$

$$\mu_{min.}\, b\, d = \left(0.225 * \frac{\sqrt{F_{cu}}}{F_y}\right) b\, d = \left(0.225 * \frac{\sqrt{25}}{360}\right) 350 * 1100 = 1203.1 \text{ mm}^2$$

$\therefore A_{s_{req.}} > \mu_{min.}\, b\, d \quad \therefore$ Take $A_s = A_{s_{req.}} = 3593.0 \text{ mm}^2$ $\quad 10\phi22$

$$\therefore n = \frac{b - 25}{\phi + 25} = \frac{350 - 25}{22 + 25} = 6.91 = 6.0 \text{ bars}$$

Sec. ② R–Sec.

$M = 554.92$ kN.m , $P = 69.86$ kN , $b = 0.35$ m , $t = 1.20$ m

Check $\frac{P}{F_{cu}\, b\, t} = \frac{69.86 * 10^3}{25 * 350 * 1200} = 0.0066 < 0.04$ (neglect P)

$\therefore 1100 = C_1 \sqrt{\frac{554.92 * 10^6}{25 * 350}} \longrightarrow C_1 = 4.36 \longrightarrow J = 0.814$

$$\therefore A_s = \frac{M_{U.L.}}{J\, F_y\, d} = \frac{554.92 * 10^6}{0.814 * 360 * 1100} = 1721.5 \text{ mm}^2$$

Check $A_{s\,min.}$ $A_{s_{req.}} = 1721.5\ mm^2$

$$\mu_{min.}\, b\, d = \left(0.225 * \frac{\sqrt{F_{cu}}}{F_y}\right) b\, d = \left(0.225 * \frac{\sqrt{25}}{360}\right) 350 * 1100 = 1203.1\ mm^2$$

$\therefore A_{s_{req.}} > \mu_{min.}\, b\, d \quad \therefore$ Take $A_s = A_{s_{req.}} = 1721.5\ mm^2$ **5ϕ22**

Sec. ③ R-Sec.

$M = 447.13$ kN.m , $P = 69.86$ kN , $b = 0.35$ m , $t = 1.20$ m

Check $\frac{P}{F_{cu}\, b\, t} = \frac{69.86 * 10^3}{25 * 350 * 1200} = 0.0066 < 0.04$ (neglect P)

$$\therefore 1100 = C_1 \sqrt{\frac{447.13 * 10^6}{25 * 350}} \longrightarrow C_1 = 4.86 \longrightarrow J = 0.826$$

$$\therefore A_s = \frac{M_{U.L.}}{J\, F_y\, d} = \frac{447.13 * 10^6}{0.826 * 360 * 1100} = 1366.9\ mm^2$$

Check $A_{s\,min.}$ $A_{s_{req.}} = 1366.9\ mm^2$

$$\mu_{min.}\, b\, d = \left(0.225 * \frac{\sqrt{F_{cu}}}{F_y}\right) b\, d = \left(0.225 * \frac{\sqrt{25}}{360}\right) 350 * 1100 = 1203.1\ mm^2$$

$\therefore A_{s_{req.}} > \mu_{min.}\, b\, d \quad \therefore$ Take $A_s = A_{s_{req.}} = 1366.9\ mm^2$ **4ϕ22**

Sec. ④ R-Sec. Neglect effect of Buckling.

$M = 447.13$ kN.m , $P = 375.1$ kN

Check $\frac{P}{F_{cu}\, b\, t} = \frac{375.1 * 10^3}{25 * 350 * 1200} = 0.035 < 0.04$ (neglect P)

$$\therefore 1100 = C_1 \sqrt{\frac{447.13 * 10^6}{25 * 350}} \longrightarrow C_1 = 4.86 \longrightarrow J = 0.826$$

$$\therefore A_s = \frac{M_{U.L.}}{J\,F_y\,d} = \frac{447.13 * 10^6}{0.826 * 360 * 1100} = 1366.9\ mm^2$$

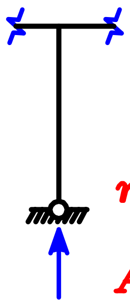
Check $s_{min.}$ $\qquad A_{s_{req.}} = 1366.9\ mm^2$

$$\mu_{min.}\,b\,d = \left(0.225 * \frac{\sqrt{F_{cu}}}{F_y}\right) b\,d = \left(0.225 * \frac{\sqrt{25}}{360}\right) 350 * 1100 = 1203.1\ mm^2$$

$$\therefore A_{s_{req.}} > \mu_{min.}\,b\,d \quad \therefore Take\ A_s = A_{s_{req.}} = 1366.9\ mm^2 \qquad 4\phi 22$$

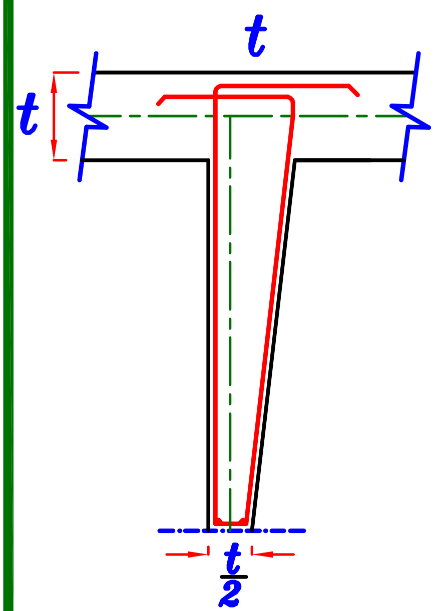
Sec. ⑤

ملحوظه هامه

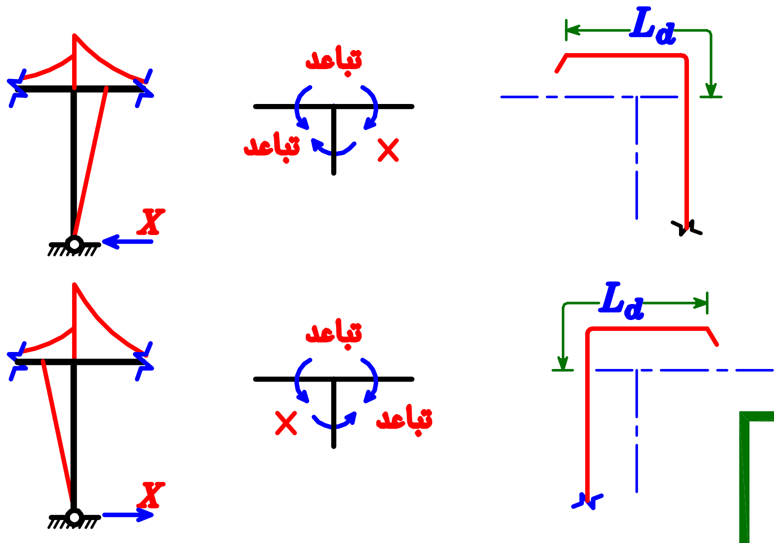


اذا كان العمود ليس *Link member* و لكن يوجد عليه *Normal* فقط
سنأخذ تخانته نفس تخانه الكمره و سنعمل على تصميم القطاع على *Normal* فقط
و سوف يكون التسليح أقل من الـ*minimum* لذا سنأخذه يساوى الـ*minimum*

$$A_{s_{total}} = A_{s_{min.}} = \frac{0.8}{100} * b * t \xrightarrow{Take} A_s = A_{s'} = \frac{A_{s_{min.}}}{2}$$



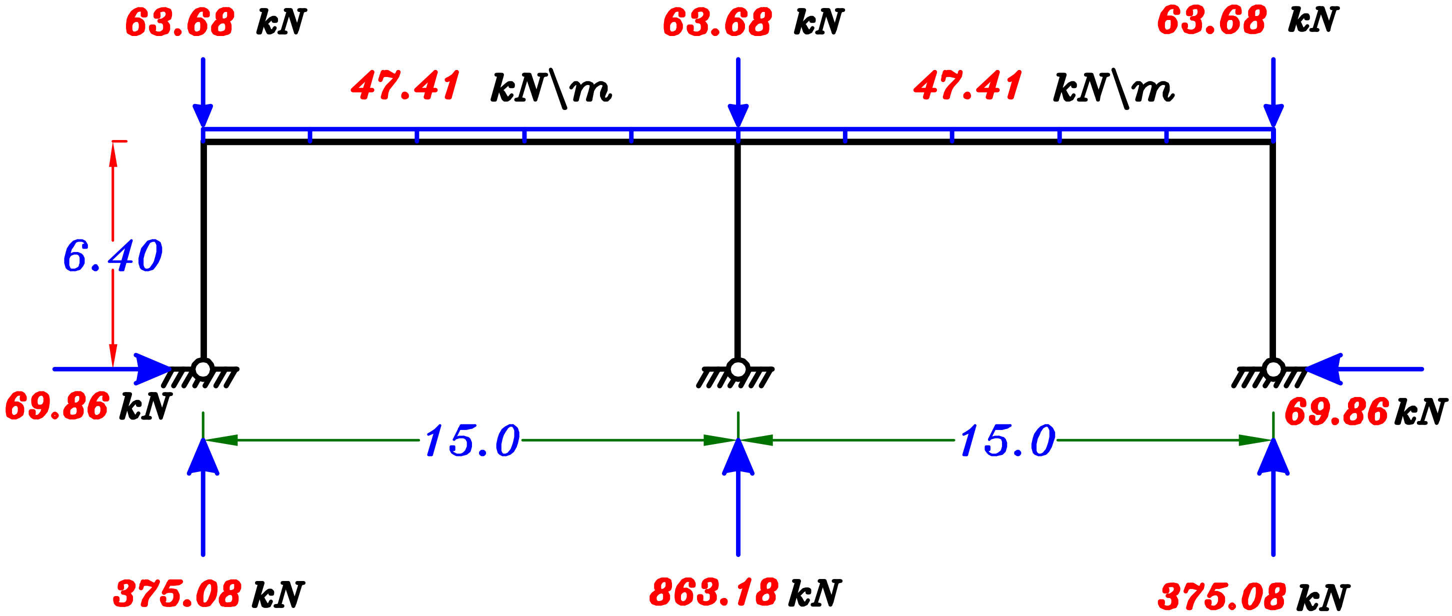
نتيجة حالات التحميل ستعمل عزم على هذا العمود

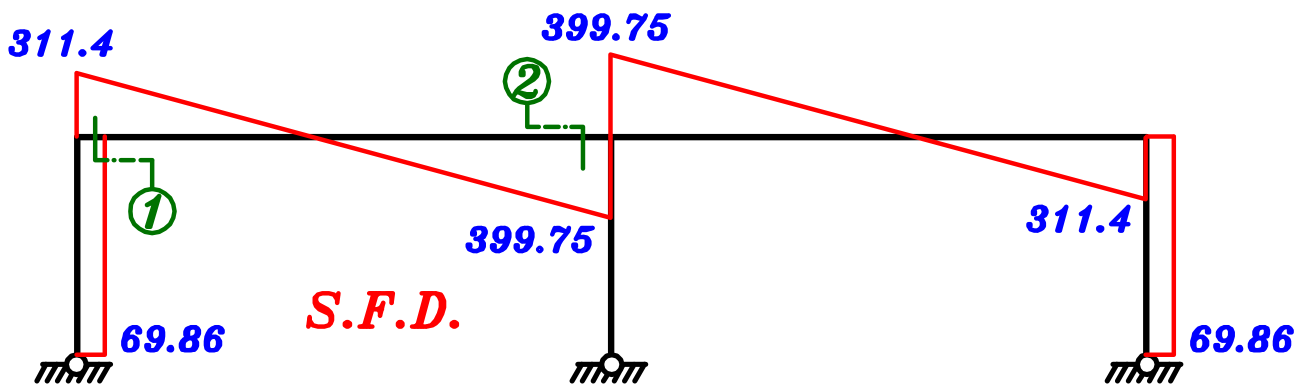


$$A_{s_{min.}} = \frac{0.8}{100} * b * t = \frac{0.8}{100} * 300 * 1200 = 2880\ mm^2$$

$$A_s = A_{s'} = \frac{A_{s_{min.}}}{2} = \frac{2880}{2} = 1440\ mm^2 \qquad 4\phi 22$$

Check Shear.





$$q_{cu} = (0.24)\sqrt{\frac{25}{1.50}} = 0.98 \ N\backslash mm^2$$

$$q_{u_{max}} = (0.70)\sqrt{\frac{25}{1.50}} = 2.85 \ N\backslash mm^2$$

Sec. 1

$$q_u = \frac{Q_{max}}{b\ d} = \frac{311.4 * 10^3}{350 * 1100} = 0.81 \ N\backslash mm^2 \qquad \because \ q_u < q_{cu}$$

$\therefore$ **Use min. Shear RFT.** $5\phi 8\backslash m$

Sec. ②

$$q_u = \frac{Q_{max}}{b\ d} = \frac{399.75 * 10^3}{350 * 1100} = 1.04\ N\backslash mm^2$$

$\therefore\ q_{cu} < q_U < q_{max.}$ $\because$ We need Stirrups more Than $5\phi 8 \backslash m'$

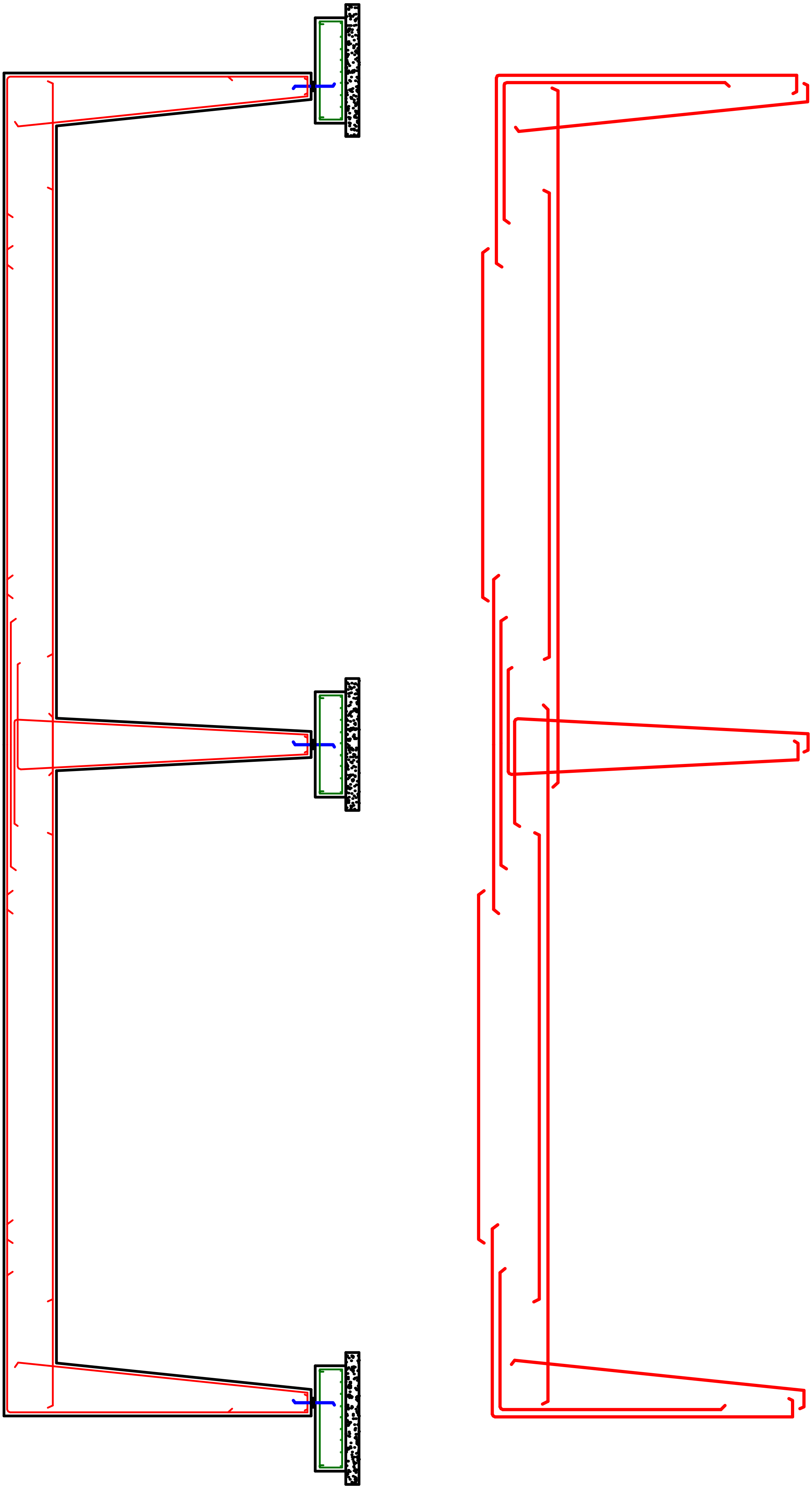
$\therefore$ Use $q_s = q_u - \frac{q_{cu}}{2} = \frac{n A_s (F_y \backslash \gamma_s)}{b\ \ S}$

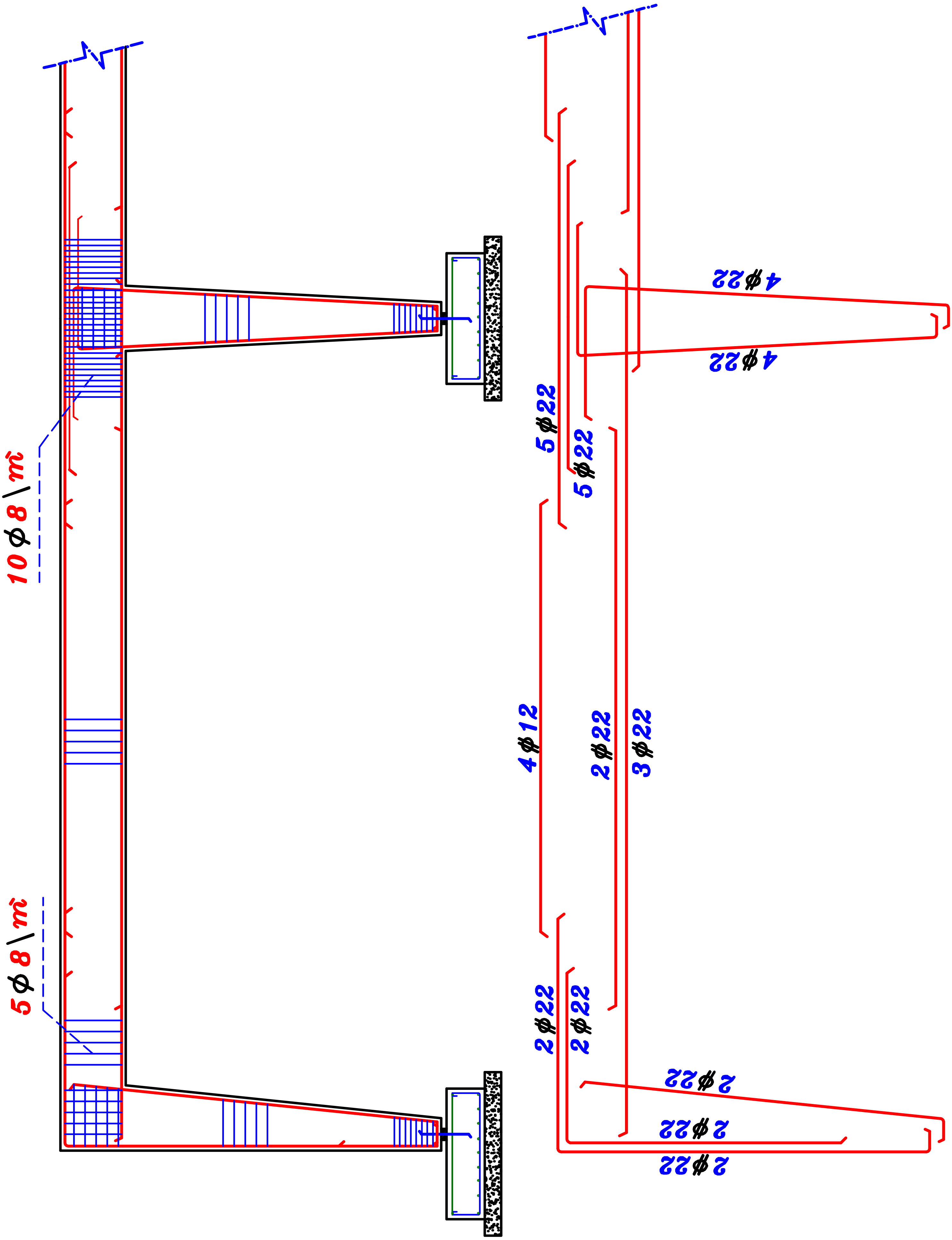
* Take $n = 2$, $\phi 8 \longrightarrow A_s = 50.3\ mm^2$

$$1.04 - \frac{0.98}{2} = \frac{2 * 50.3\ (240 \backslash 1.15)}{350 * S} \longrightarrow S = 109.06\ mm > 100\ mm \therefore o.k.$$

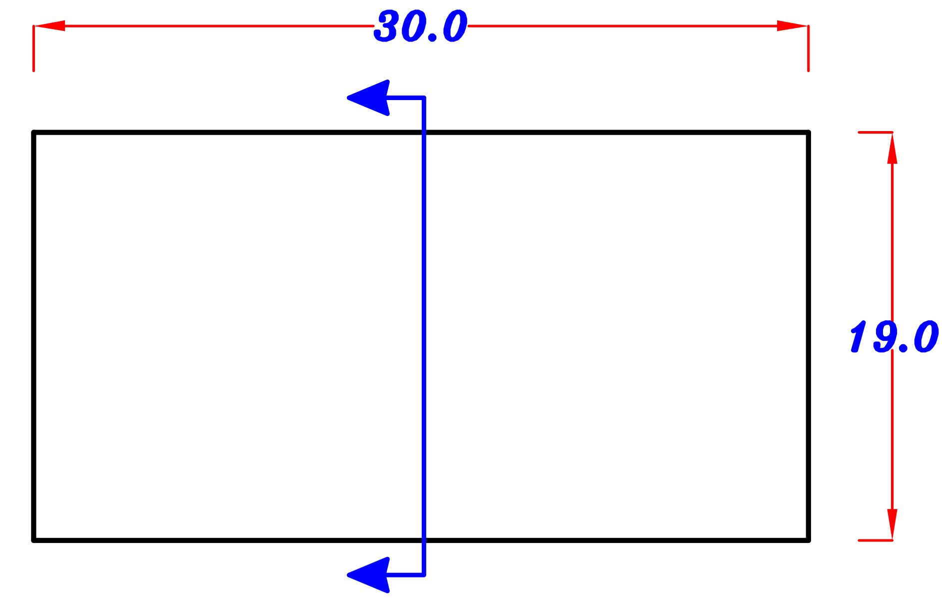
$\therefore$ No. of stirrups$\backslash m'$ $= \frac{1000}{S} = \frac{1000}{109.06} = 9.16 = 10 \backslash m'$

$\therefore$ Use Stirrups $\boxed{10\phi 8 \backslash m'}$ 2 branches

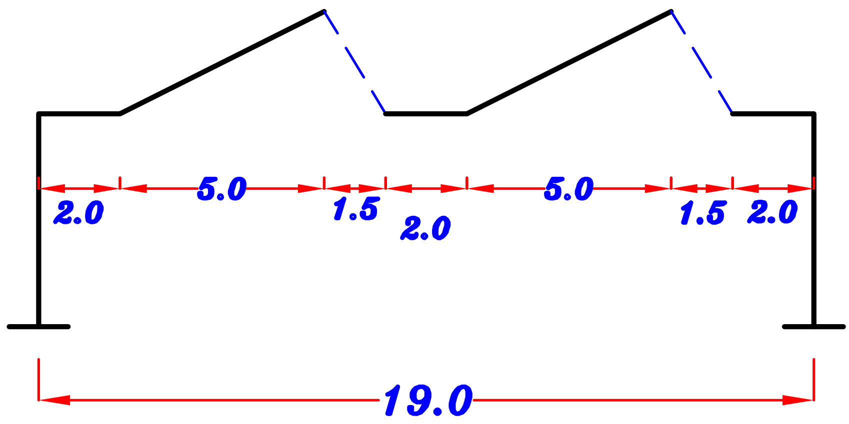



10 Φ 8 \ m'
5 Φ 8 \ m'
4 Φ 22
4 Φ 22
5 Φ 22
5 Φ 22
4 Φ 12
2 Φ 22
3 Φ 22
2 Φ 22
2 Φ 22
2 Φ 22
2 Φ 22
2 Φ 22

Example.

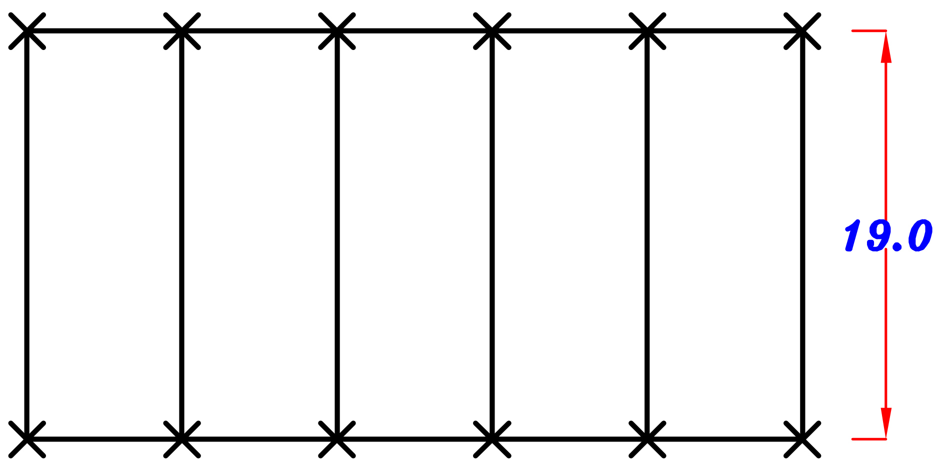


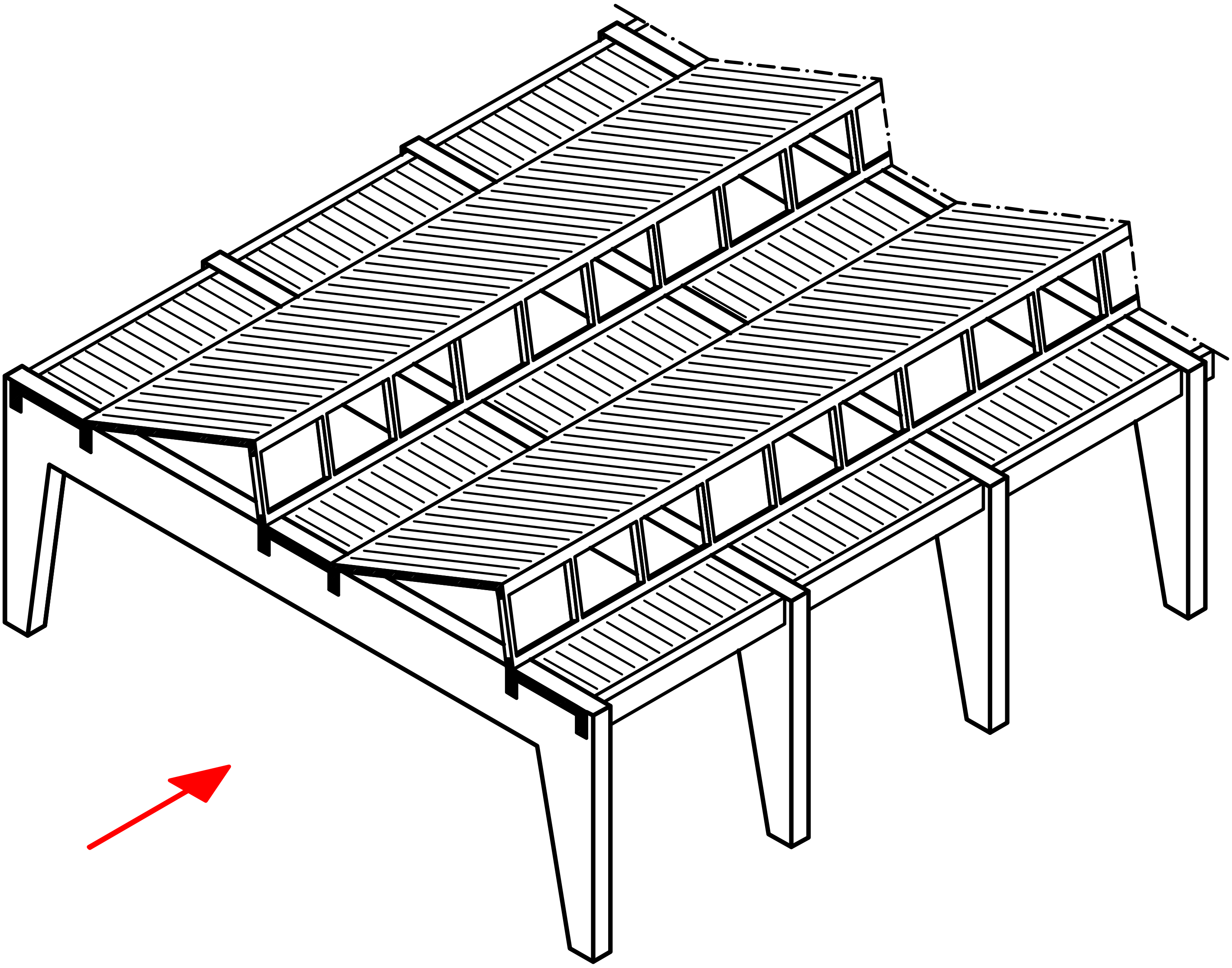
Columns are allowed at outer perimeter.

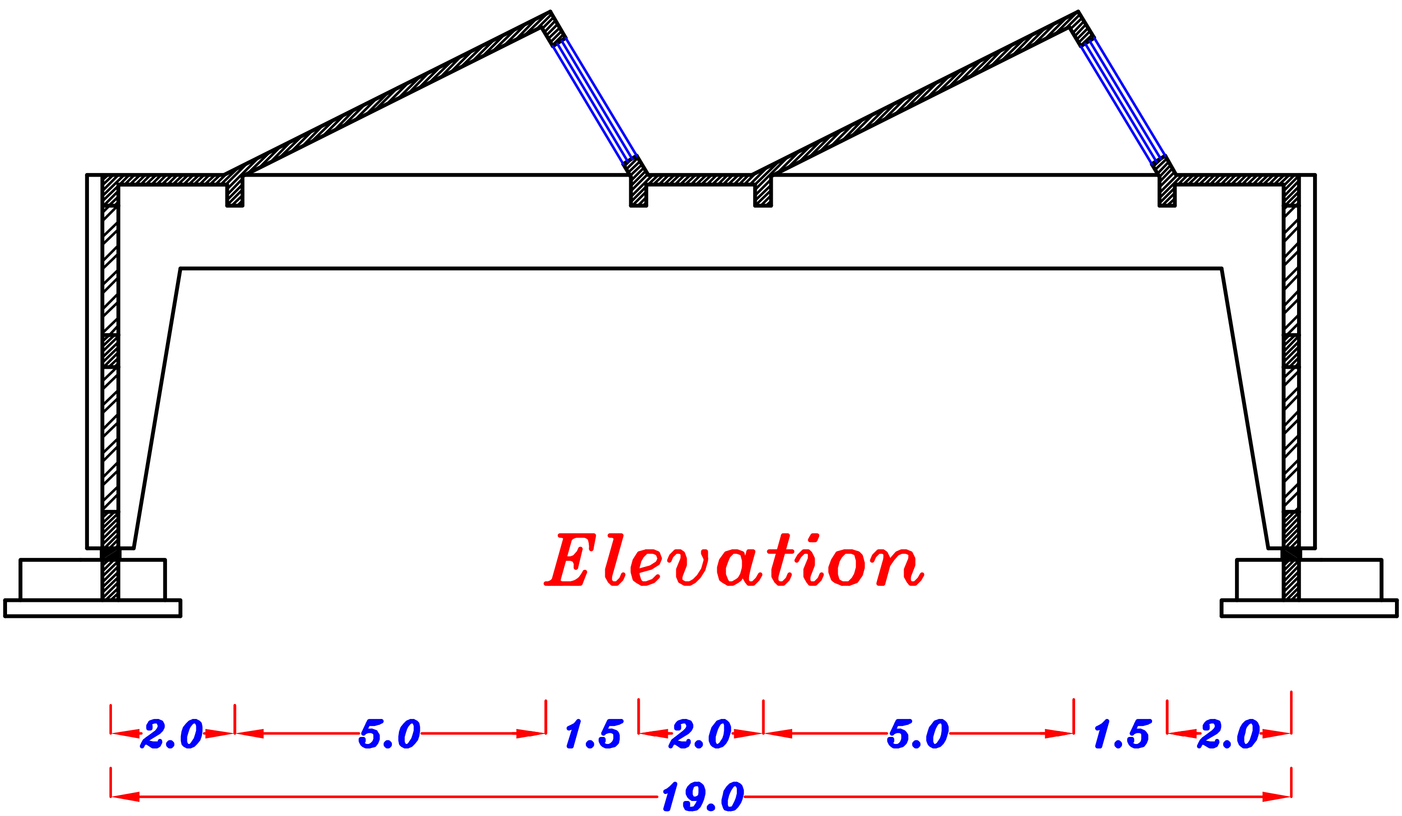


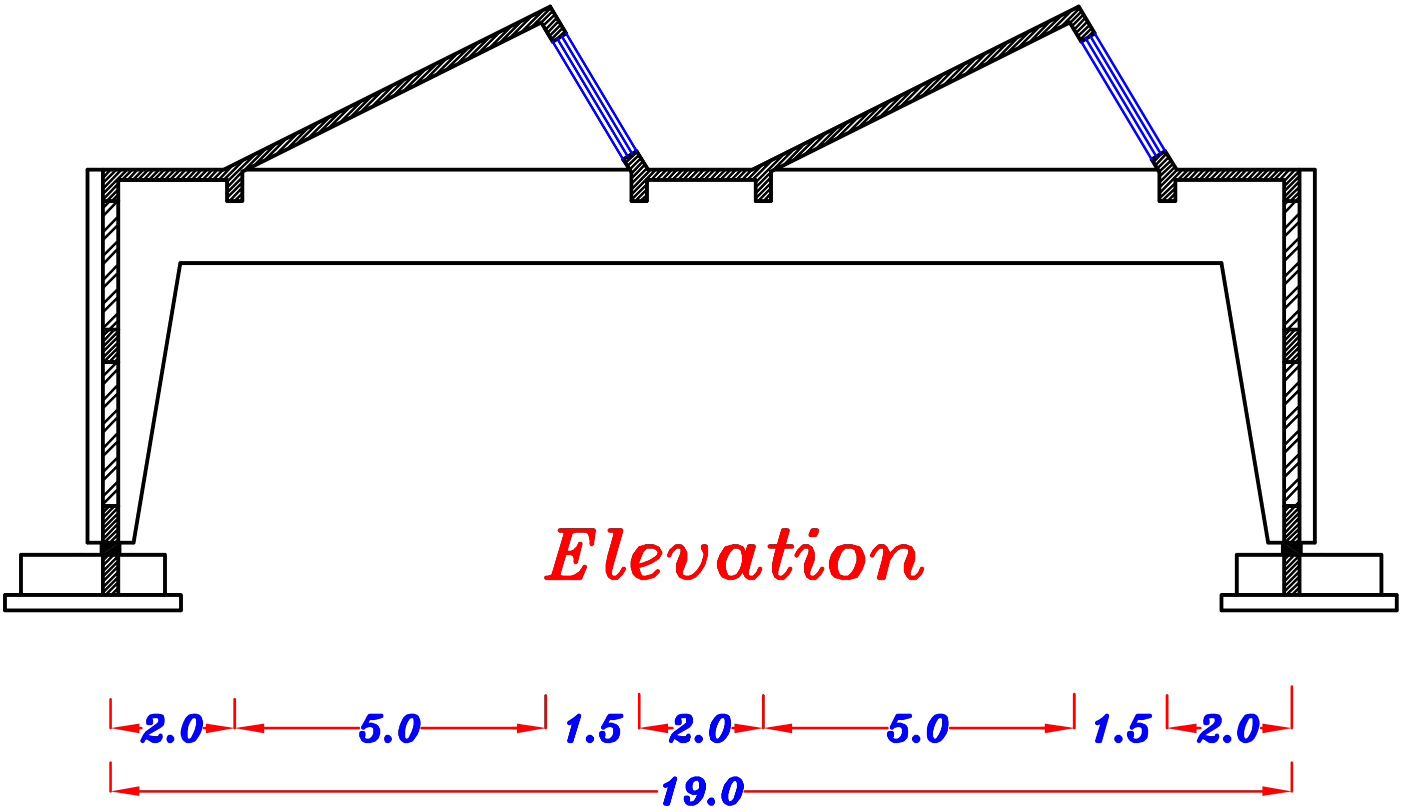
Choose a convenient Statical System and draw a sketch For an elevation Showing Concrete Dimensions and RFT.

Use 2-Hinged Frame with span 19.0 m

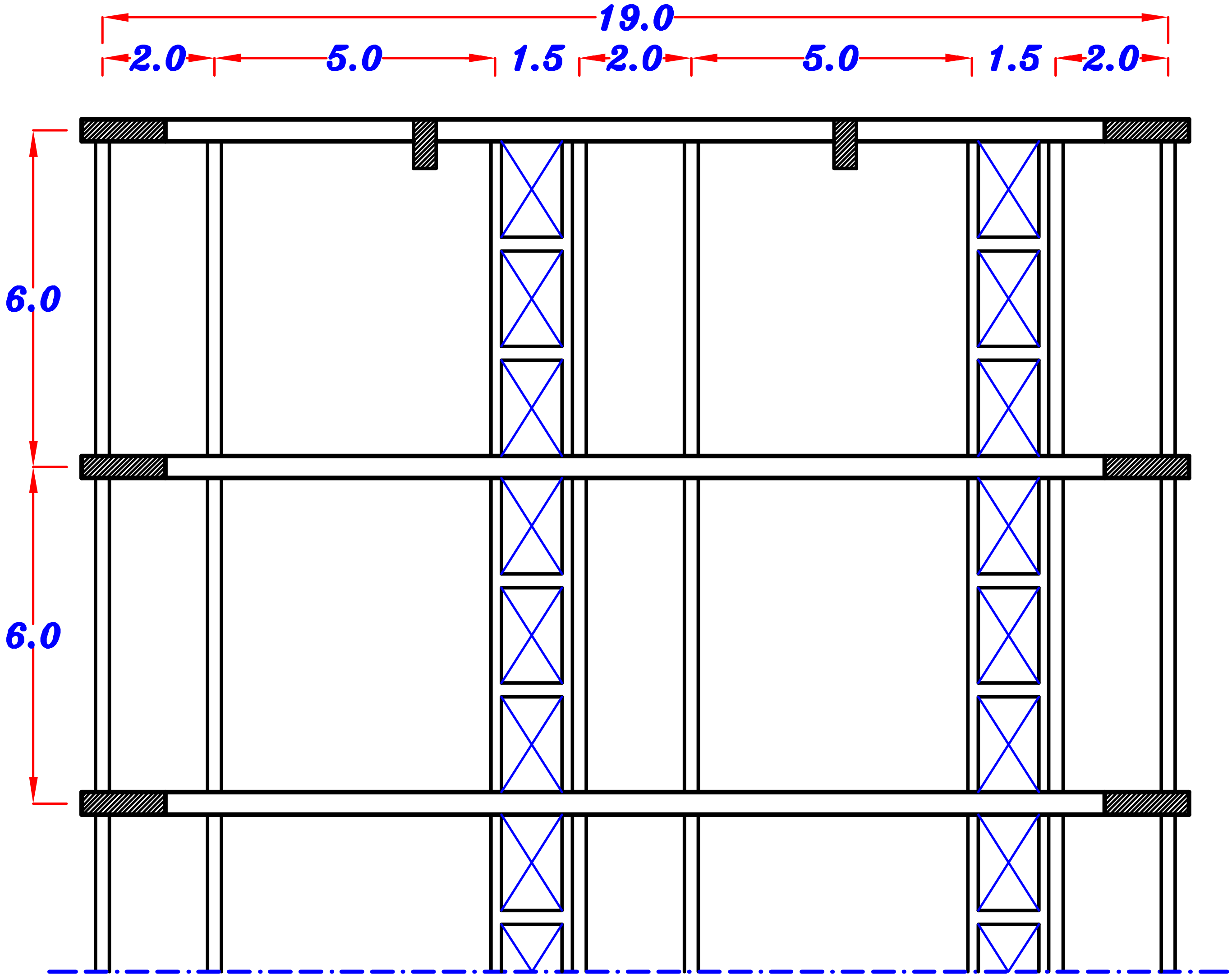





Elevation
2.0
5.0
1.5
2.0
5.0
1.5
2.0
19.0



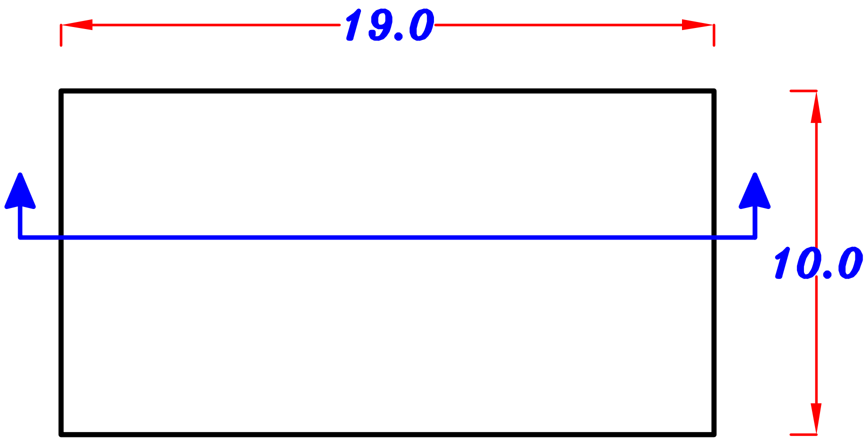
Elevation

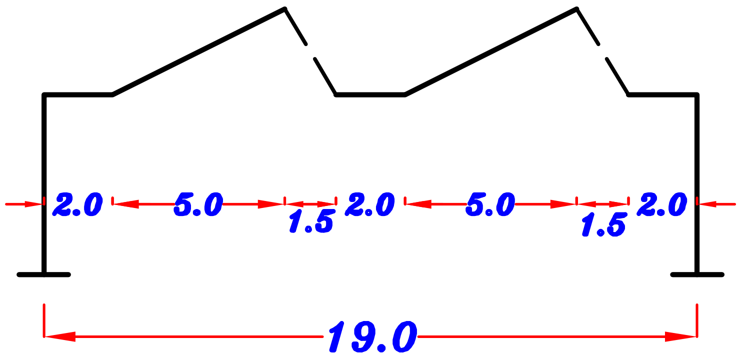


Plan

Example.

Columns are allowed at outer perimeter.

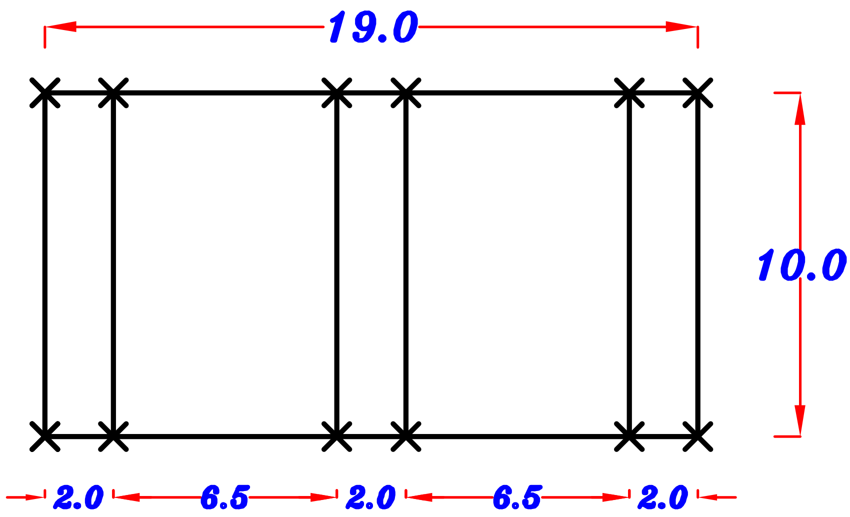


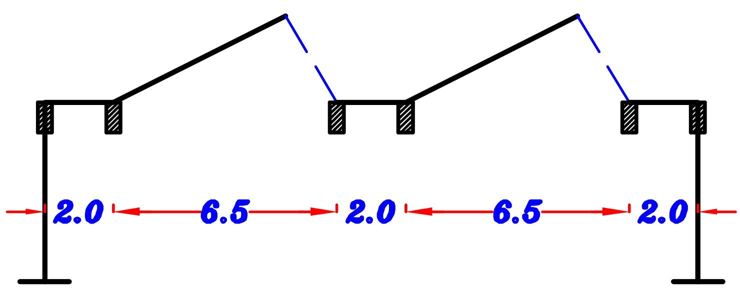


Choose a convenient Statical System and draw a sketch For an elevation Showing Concrete Dimensions and RFT.

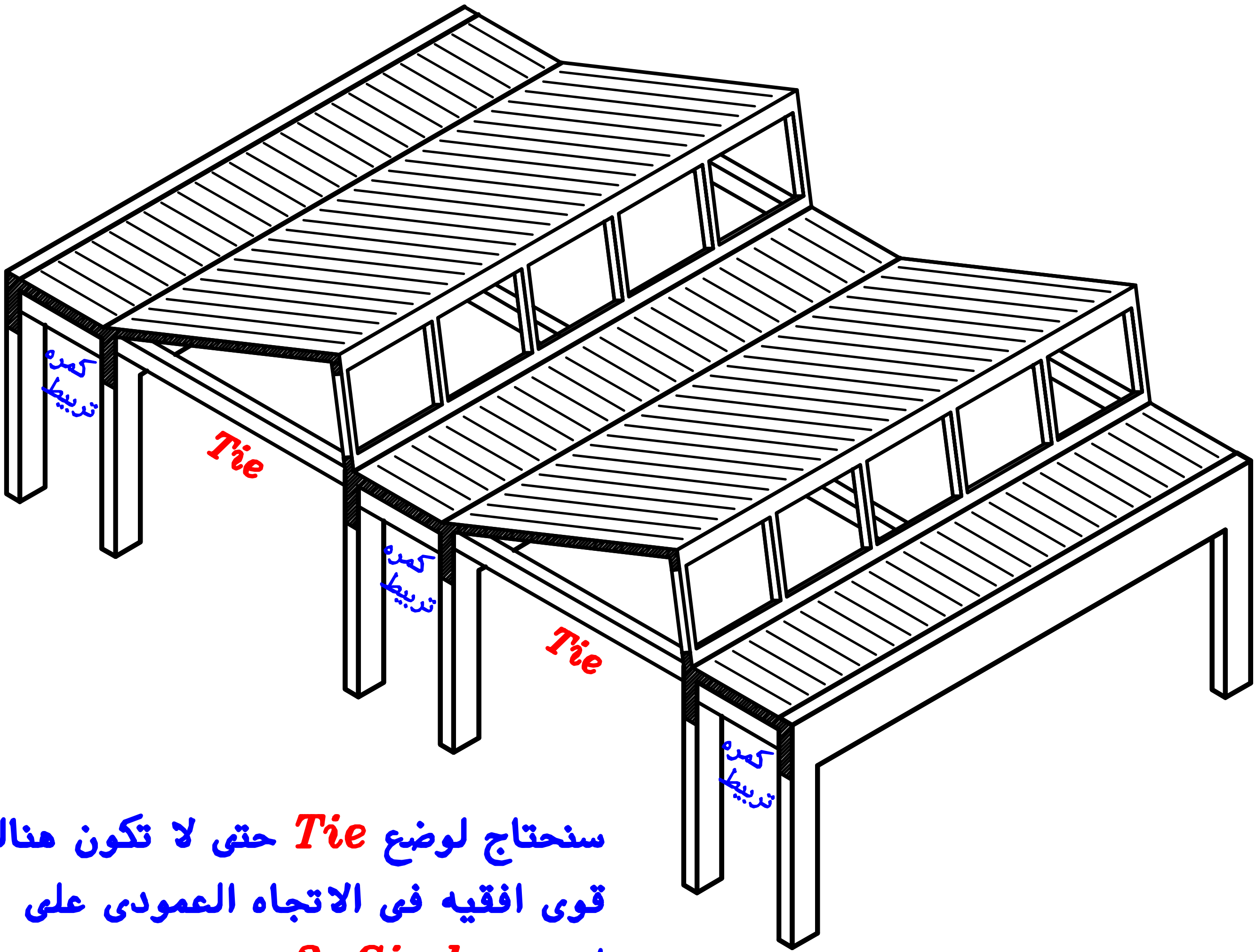
Use Simple Girder with span 10.0 m

سنحتاج لتكرار ال Girder
على مسافات غير متساويه
حتى نتمكن من حمل البلاطه .

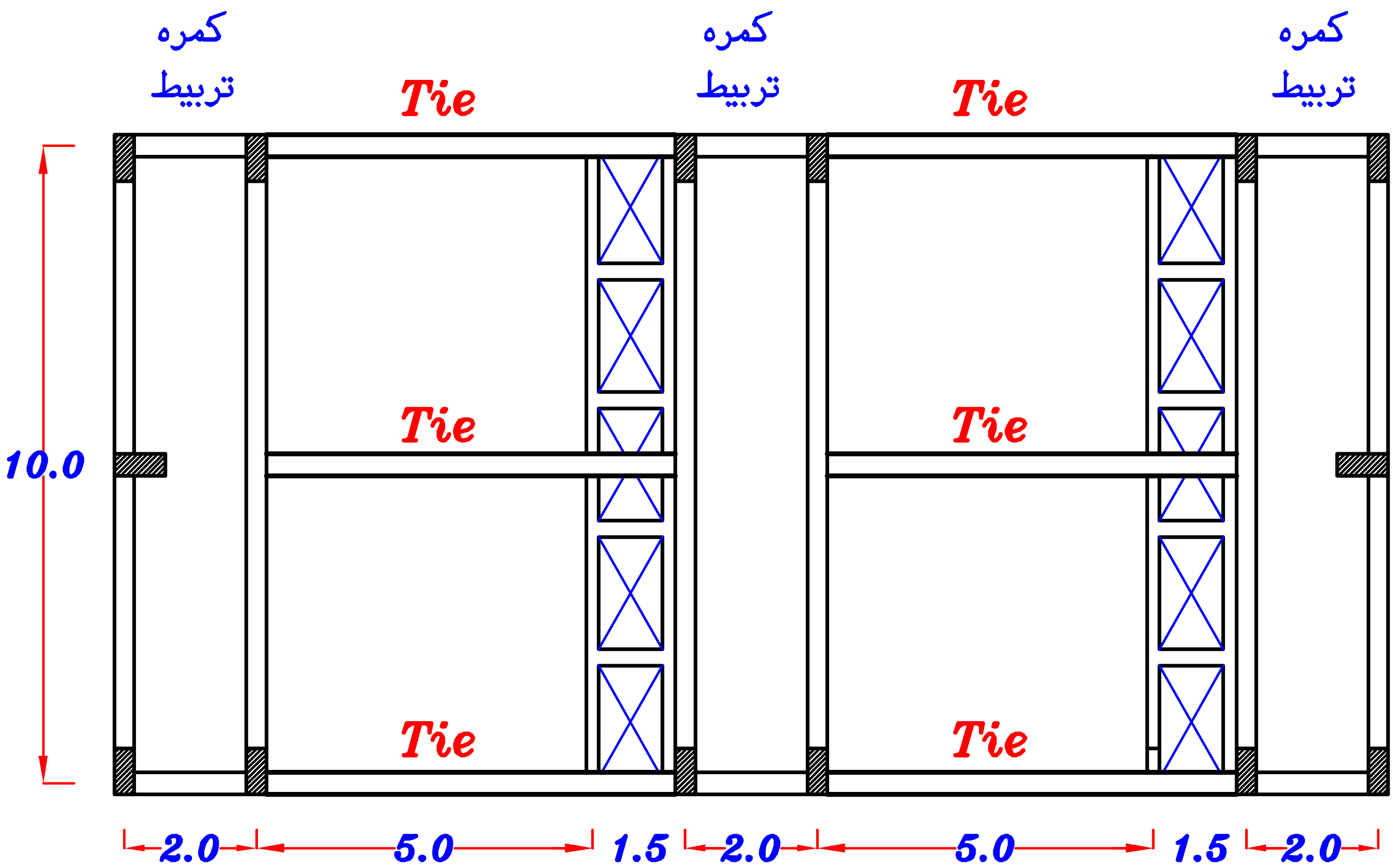




Plan



سنحتاج لوضع Tie حتى لا تكون هناك
قوى افقيه فى الاتجاه العمودى على
2 Girders اخر



Plan

Example.

The Figure shows Elevation Y–Y of the shed covering a show room. The show room is 60 meter long and 8.0 meter wide with no internal column allowed. Glass windows and brick walls are placed along the perimeter of the room as shown. Main supporting systems are spaced 6.0 meters. One way hollow blocks slabs are used For Part CD and solid slabs are used For the rest of slabs.

Given:

Total external load on the roof (i.e. roof cover and live load) are 4 kN/m^2

Concrete characteristic strength is 25 MPa.

Steel grade is 400/600 For main reinforcement and 240/350 For stirrups.

Required:

1- Choose a convenient covering main system For the show room and then without any calculation, but with reasonably assumed concrete dimensions, draw to scale 1:100 a vertical cross section Y–Y including the Foundations.

2- Draw a structural plan For the show room to scale 1:200 showing all concrete dimensions.

3- Design the slabs and draw its details of reinforcement on a plan to scale 1:50 and cross sections to scale 1:10.

4- Design an intermediate panel of the beam at E.

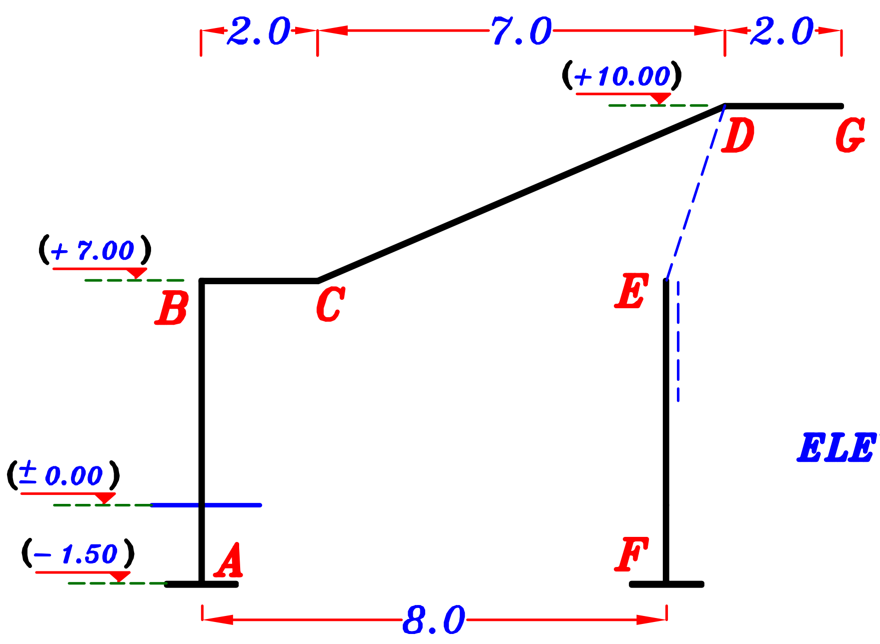
5- Design the main supporting element (ABC) and draw its details of reinforcement in elevation to scale 1:50 and cross sections to scale 1:10.

6- Design the column (EF) and draw its details of reinforcement in cross section 1:10.

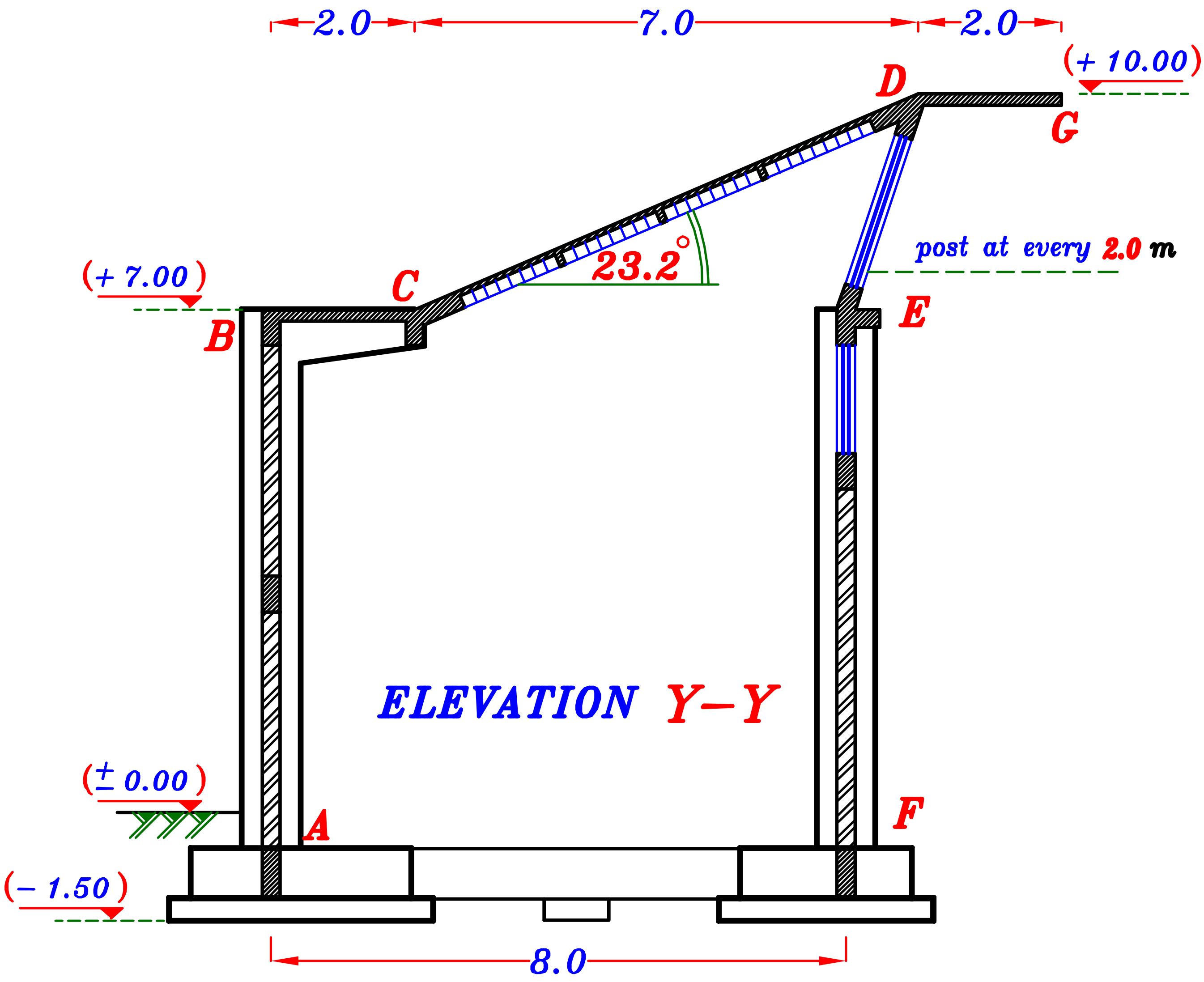
7- IF an element is added between Point C and E, perform the Following:

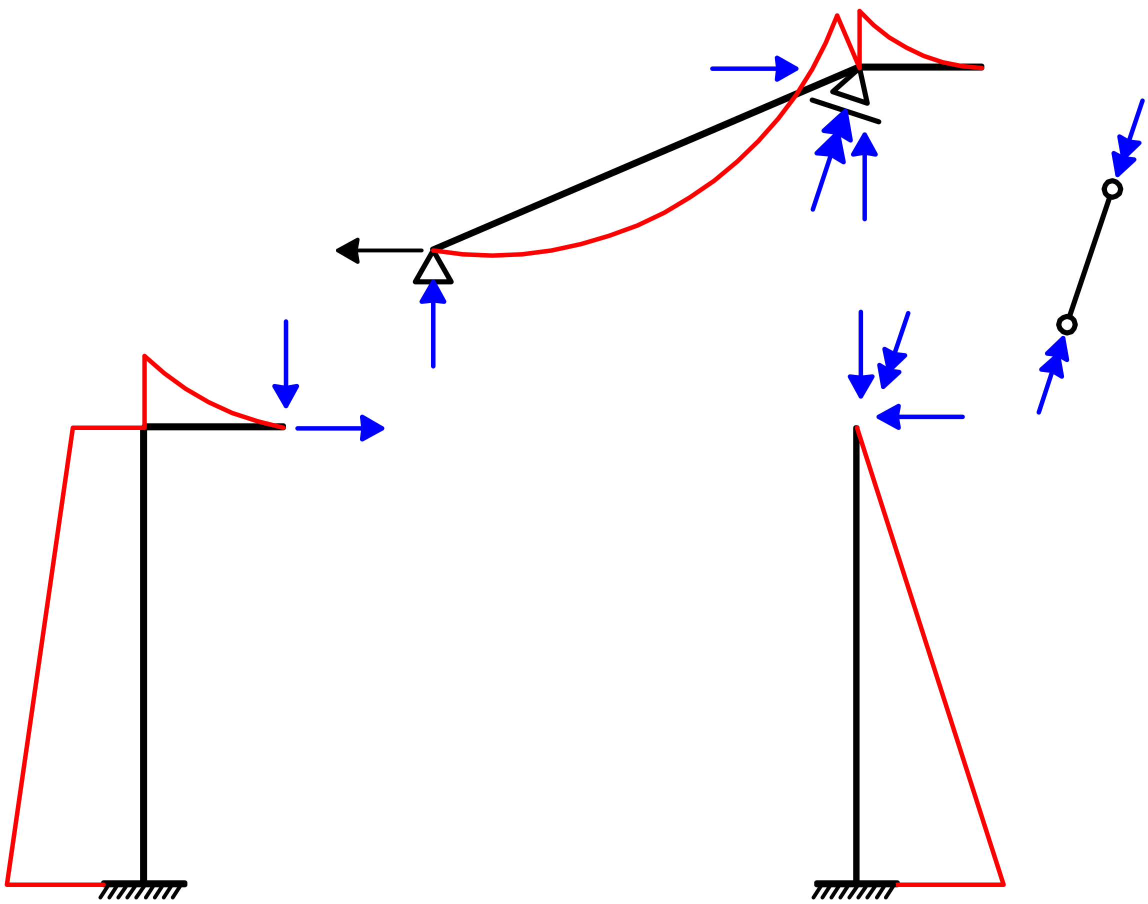
a- Draw Elevation Y–Y showing element (CE) with its minimum accepted dimensions. Show the eccentricity of the Footings at A and F.

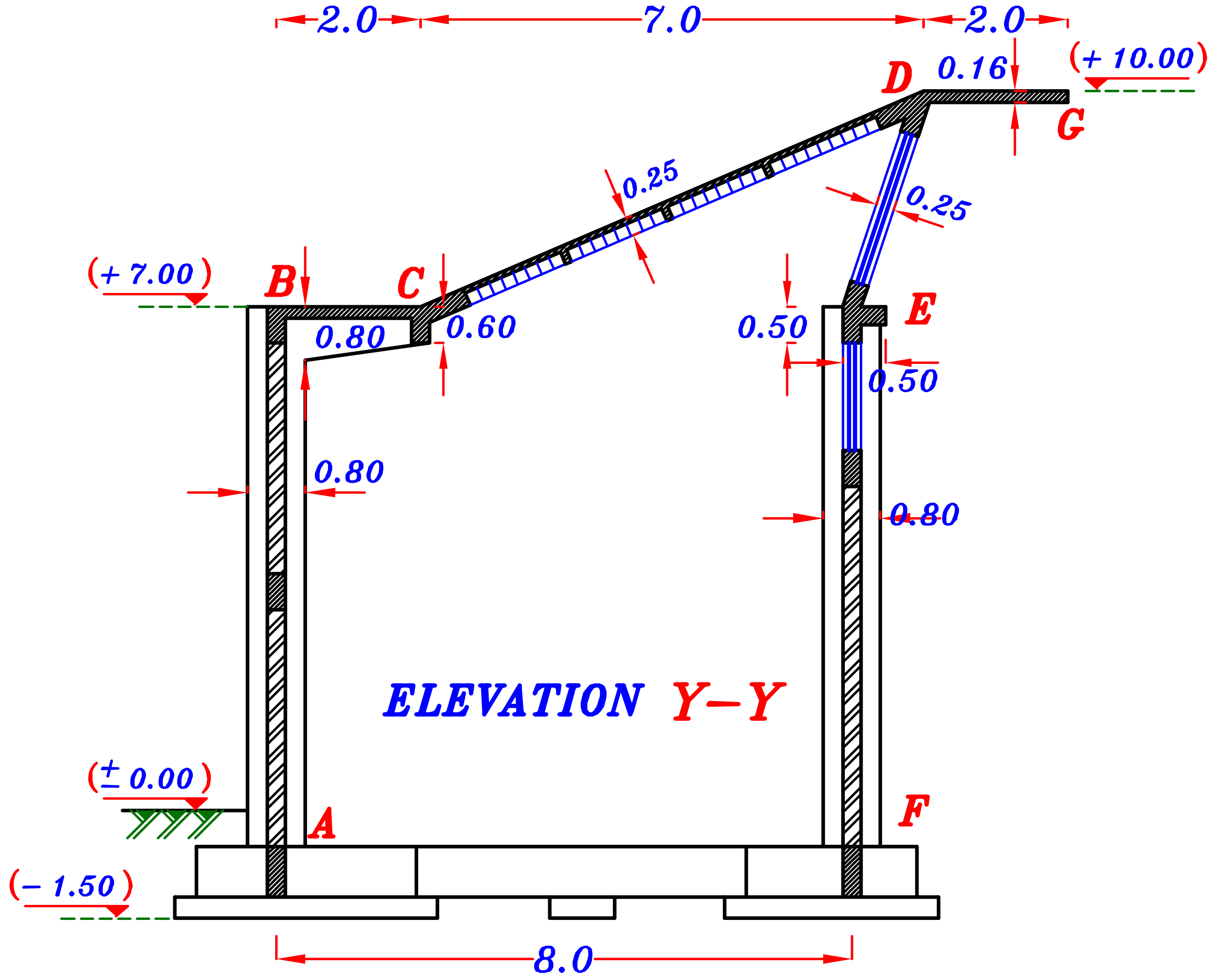
b - Design this element and draw its details of reinforcement in cross section.



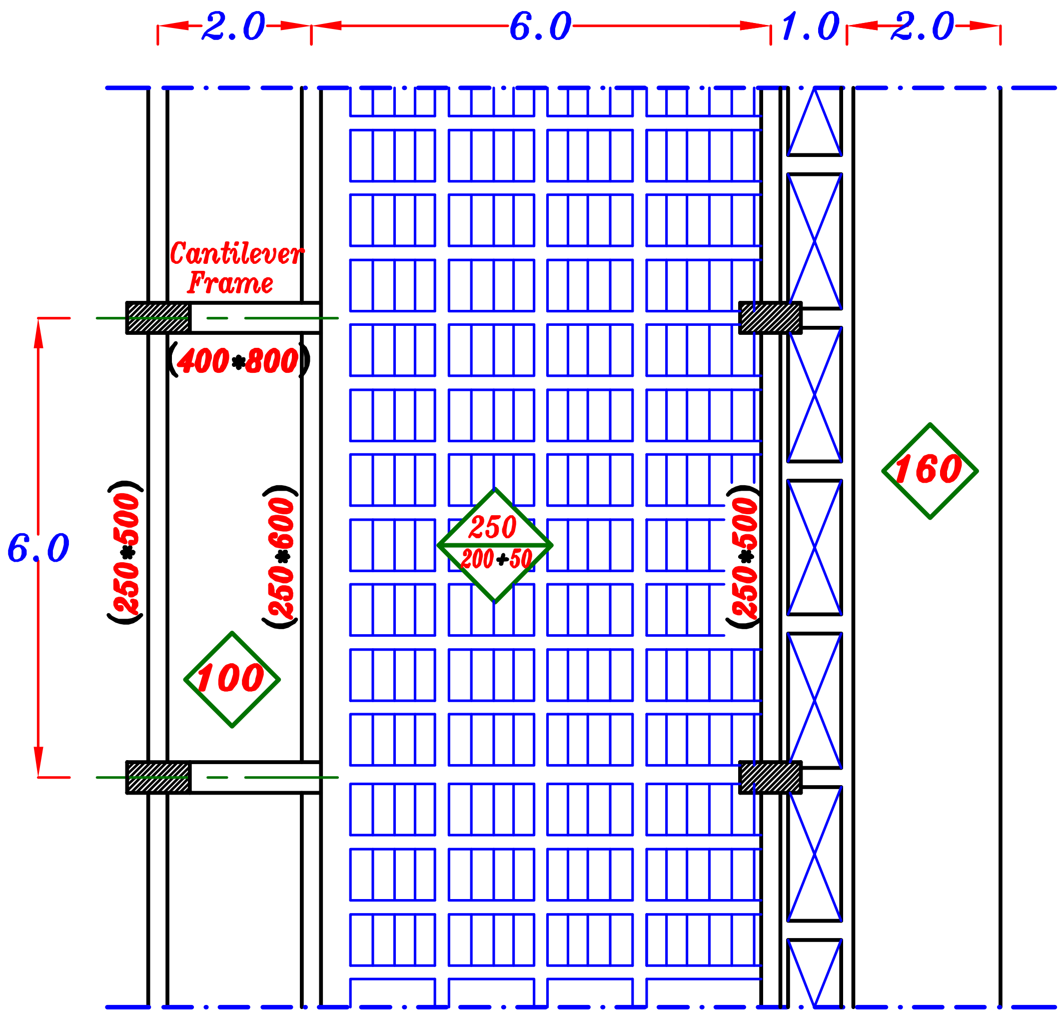
ELEVATION Y–Y


2.0
7.0
2.0
(+ 10.00)
D
G
post at every 2.0 m
23.2°
(+ 7.00)
C
B
E
ELEVATION Y–Y
(± 0.00)
A
F
(– 1.50)
8.0

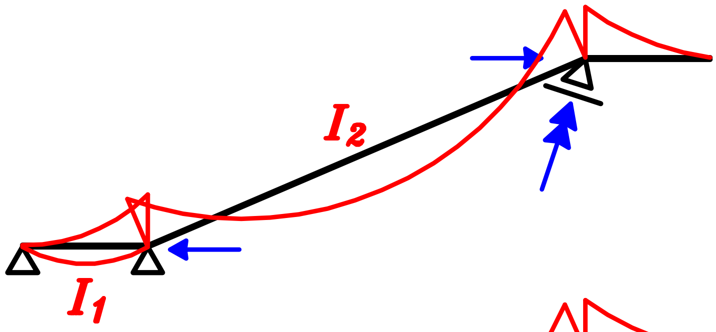




ELEVATION Y–Y



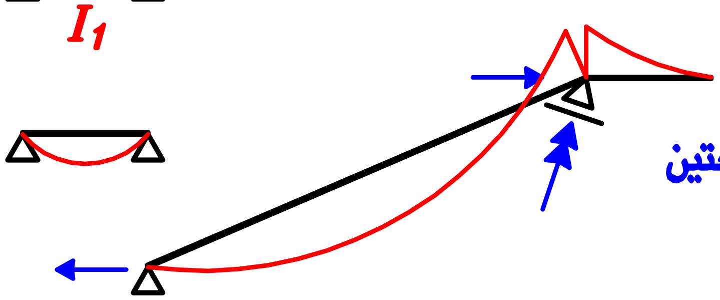
PLAN



حل هذه الشريحه صعب جدا جدا

و يفضل لحلها Exact

ان تحل بال Virtual work



ممكن للتسهيل فصل الشريحه الى شريحتين

For Solid Slab B C

$t_s = \frac{2000}{25} = 80$ mm Take $\boxed{t_s = 100 \text{ mm}}$

$w_s = 1.5\,(0.10 * 25 + 4.0) = 9.75 \text{ kN}\backslash m^2$

For Cantilever Solid Slab. D G

$t_s = \frac{2000}{10} = 200$ mm Take $\boxed{t_s = 160 \text{ mm}}$

$w_s = 1.5\,(0.16 * 25 + 4.0) = 12.0 \text{ kN}\backslash m^2$

For Hollow Blocks Slab C D

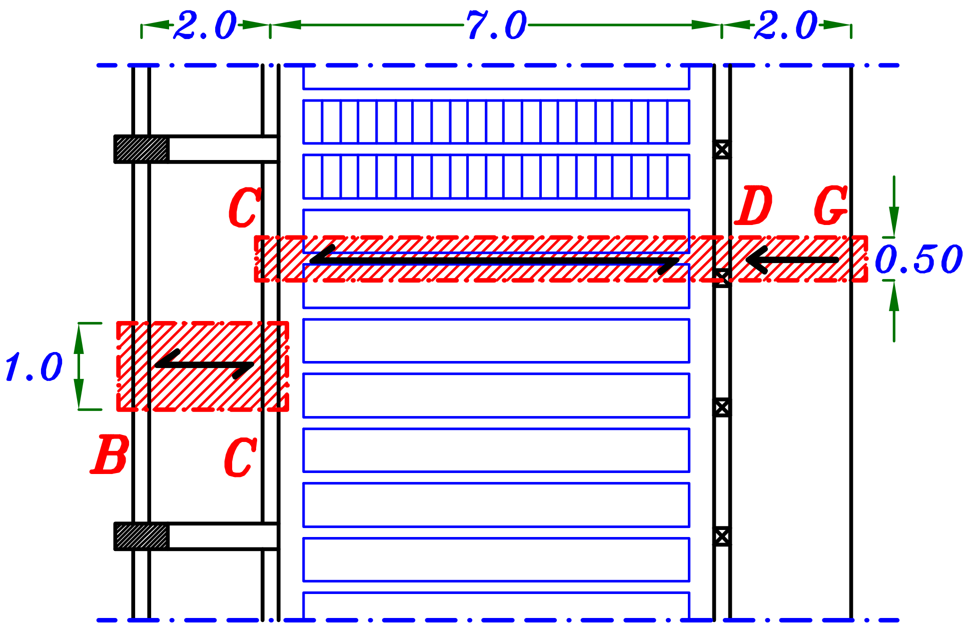
$$t = \frac{7615}{30 \rightarrow 35} = (253.8 \rightarrow 217.57) = 250 \text{ mm}$$

$\boxed{t = 250 \text{ mm}}$ $\boxed{t_s = 50 \text{ mm}}$ $\boxed{h = 200 \text{ mm}}$

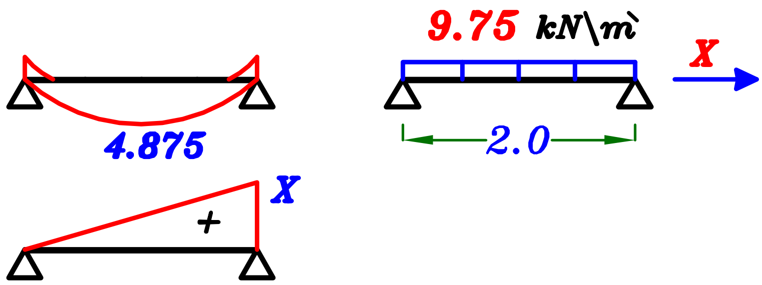
Weight of Block $= 150$ N , $S = e + b = 0.4 + 0.1 = 0.5$ m

$$\boxed{w_{ribi} = 1.5\left[\, t_s \gamma_c + (F.C. + L.L.)\ \cos\theta \,\right](S * 1.0) + 1.4\,(b\,h * 1.0m * \gamma_c) + 1.4 * (\text{Block وزن ال})\left(\frac{1.0}{a}\right)}$$

$$\therefore w_{ribi} = 1.5\left[\,0.05 * 25 + (4.0)\cos 23.2^{\circ}\,\right](0.50 * 1.0)$$
$$+ 1.4\,(0.10 * 0.20 * 1.0 * 25) + 1.4\left(\frac{150}{1000}\right)\left(\frac{1.0}{0.2}\right) = 5.44$$



Strip ① B C



Neglect the Tension on the slaband design on B.M. only.

$M_{U.L.} = 4.875$ kN.m\m , $t_s = 100$ mm , $d = 100 - 20 = 80$ mm

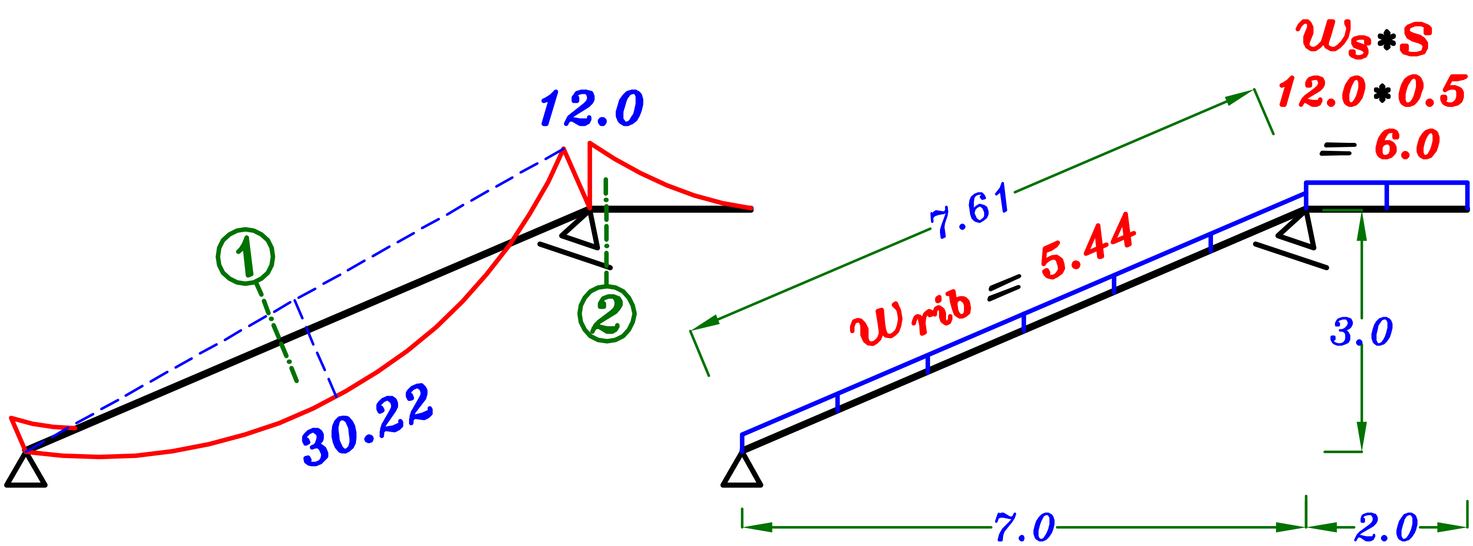
$80 = C_1 \sqrt{\dfrac{4.875 * 10^6}{25 * 1000}} \longrightarrow C_1 = 5.73 \longrightarrow J = 0.826$

$A_s = \dfrac{4.875 * 10^6}{0.826 * 400 * 80} = 184.44$ mm²/m`

5 Φ 10\m`

Strip ② C D G

Strip width = 0.50 m



Sec. 1 $M = 30.22$ kN.m\rib $d = 250 - 30 = 220$ mm

$$220 = C_1 \sqrt{\frac{30.22 * 10^6}{25 * 500}} \rightarrow C_1 = 4.474 \rightarrow J = 0.818$$

$$A_s = \frac{M}{J F_y d} = \frac{30.22 * 10^6}{0.818 * 400 * 220} = 419.82 \text{ mm}^2\text{\rib}$$

$\boxed{2\Phi 18\text{\rib}}$

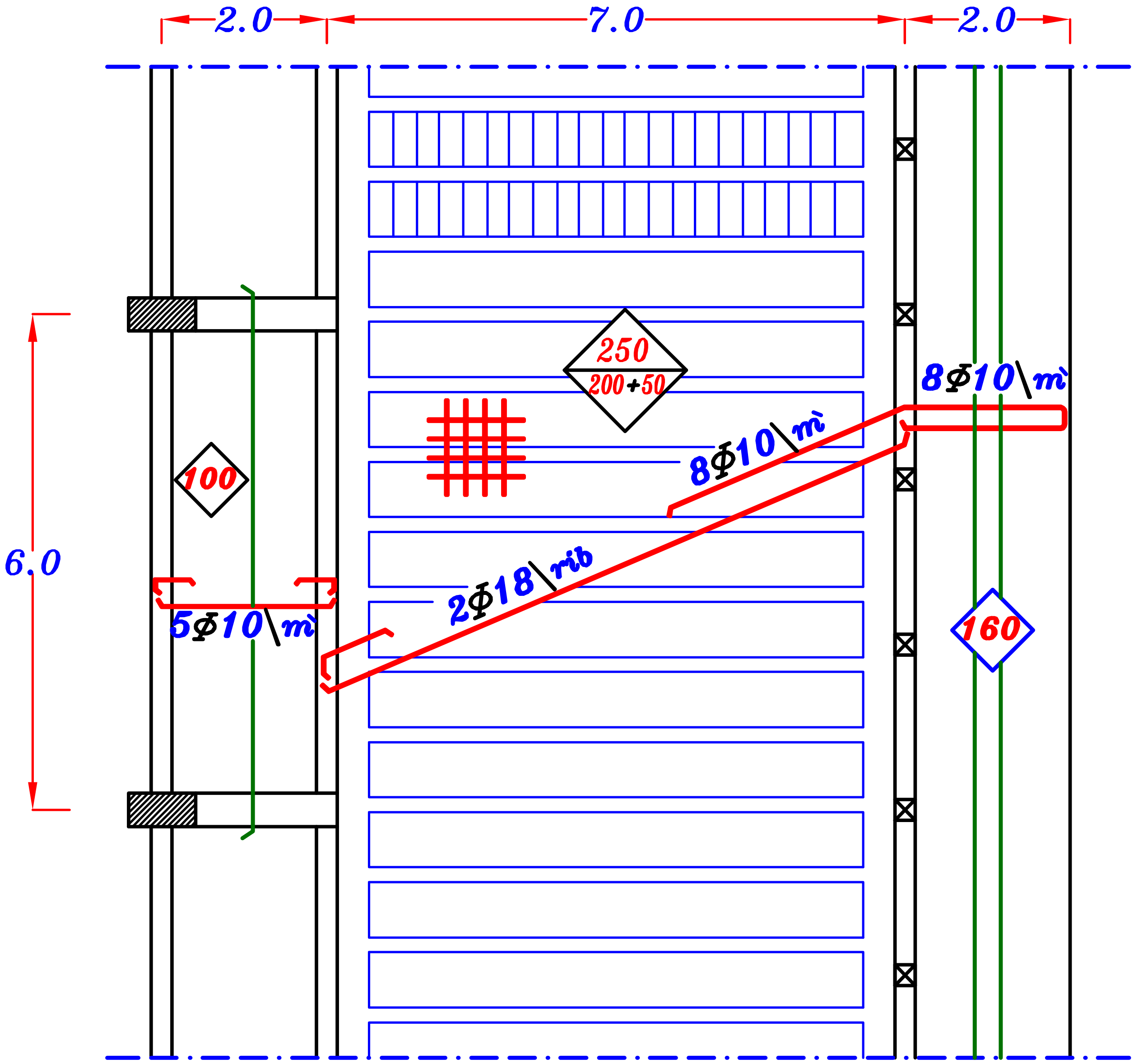
Sec. 2 $M_{U.L.} = 12.0$ kN.m\0.5m

, $t_s = 160$ mm , $d = 160 - 20 = 140$ mm

$$140 = C_1 \sqrt{\frac{12.0 * 10^6}{25 * 500}} \rightarrow C_1 = 4.52 \rightarrow J = 0.819$$

$$A_s = \frac{12.0 * 10^6}{0.819 * 400 * 140} = 261.64 \text{ mm}^2/\text{m}'$$

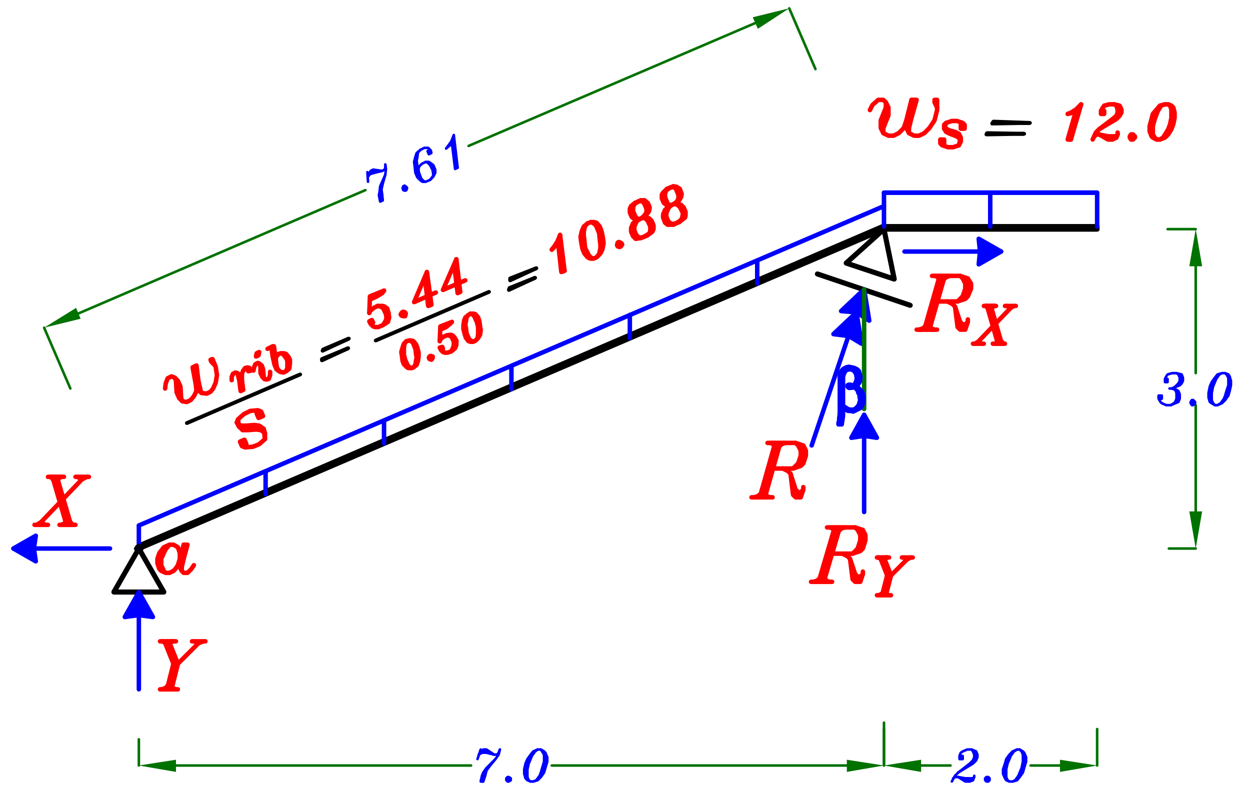
$8\Phi 10\text{\m}'$ رقم زوجي



4-Design an intermediate panel of the beam at E.

Strip C D G

Strip width = 1.0 m $\qquad \beta = 18.43^\circ$



$$R_Y = R \ Cos \ 18.43^\circ \qquad R_X = R \ Sin \ 18.43^\circ$$

$\because \sum M_a = Zero$

$\therefore \ 10.88(7.61)(3.5) + 12.0(2.0)(8.0) - R \ Cos \ 18.43^\circ \ (7.0)$

$+ \ R \ Sin \ 18.43^\circ (3.0) = Zero$

$\therefore \ R = 84.63 \ kN\backslash m'$

$\therefore \ R_Y = R \ Cos \ \beta = (84.63) \ Cos \ 18.43^\circ = 80.29 \ kN\backslash m'$

$R_X = R \ Sin \ \beta = (84.63) \ Sin \ 18.43^\circ = 26.75 \ kN\backslash m'$

$X = R_X = 26.75 \ kN\backslash m'$

$Y = 10.88(7.61) + 12.0(2.0) - 80.29 = 26.50 \ kN\backslash m'$

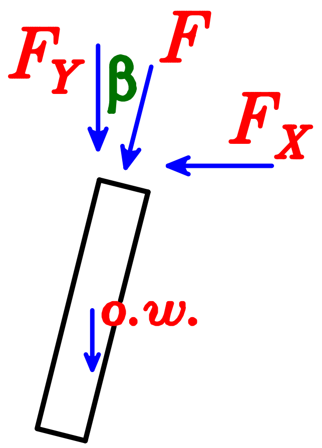
Ridge Beam. (250*400)

Take Distance between Posts. $a = 2.0$ m.

$$\boxed{w = R + o.W. * \cos\beta} = 84.63 + 4.20 * \cos 18.43^\circ = 88.61 \text{ kN}\backslash\text{m}$$

$$\boxed{R_1 = w * a} \quad R_1 = 88.61 * 2.0 = 177.22 \text{ kN}$$

Post. (250*250)

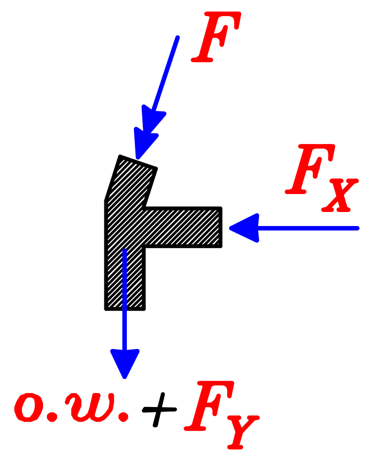


$$\boxed{F = R_1 + o.W.\,(Post) * \cos\beta}$$

$$F = 177.22 + 3.50 * \cos 18.43^\circ = 180.54 \text{ kN}$$

$$\boxed{F_Y = F * \cos\beta}$$

$$F_Y = 180.54 * \cos 18.43^\circ = 171.28 \text{ kN}$$



$$\boxed{F_X = F * \sin\beta}$$

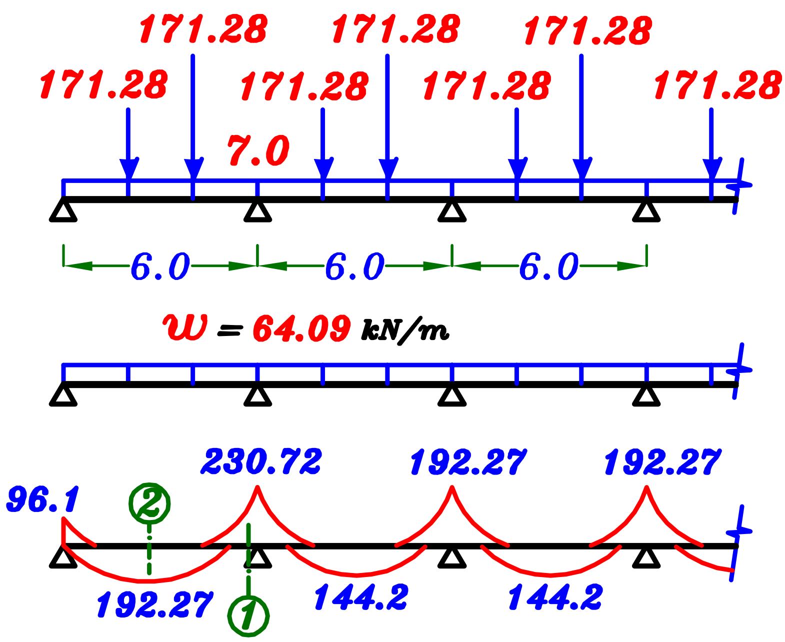
$$F_X = 180.54 * \sin 18.43^\circ = 57.08 \text{ kN}$$

End Beam E

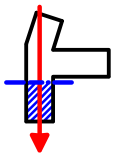
$o.w. = 7.0$ kN/m

VL. Beam.

$$w = 7.0 + \frac{2 * 171.28}{6.0} = 64.09 \text{ kN/m}$$



Sec. ① $M_{U.L.} = 230.72\ kN.m$ R−sec.



Take $C_1 = 3.50 \rightarrow J = 0.78$

$$d = 3.50\sqrt{\frac{230.72 * 10^6}{25 * 250}} \rightarrow d = 672.4\ mm \quad \boxed{d = 700\ mm} \quad \boxed{t = 750\ mm}$$

$$A_s = \frac{230.72 * 10^6}{0.780 * 400 * 505.5} = 1099.8\ mm^2$$

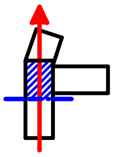
Check $A_{s\,min.}$ $A_{s_{req.}} = 1099.8\ mm^2$

$$\mu_{min.}\, b\, d = \left(0.225 * \frac{\sqrt{F_{cu}}}{F_y}\right) b\, d = \left(0.225 * \frac{\sqrt{25}}{400}\right) 250 * 700 = 492.2\ mm^2$$

$\therefore A_{s_{req.}} > \mu_{min.}\, b\, d \quad \therefore$ Take $A_s = A_{s_{req.}} = 1099.8\ mm^2$ 6 Φ16

$$\therefore n = \frac{b - 25}{\phi + 25} = \frac{250 - 25}{16 + 25} = 5.48 = 5.0 \text{ bars}$$

Sec. ② $M_{U.L.} = 192.27\ kN.m$ R−sec.

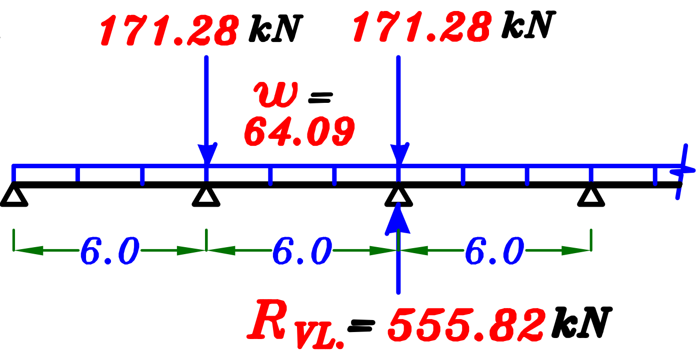


$$550 = C_1\sqrt{\frac{192.27 * 10^6}{25 * 250}} \rightarrow C_1 = 3.99 \rightarrow J = 0.803$$

$$A_s = \frac{192.27 * 10^6}{0.803 * 400 * 700} = 855.1\ mm^2 > \mu_{min.}\, b\, d$$

$A_s = 855.1$ 5 Φ16

Reaction of VL. Beam.

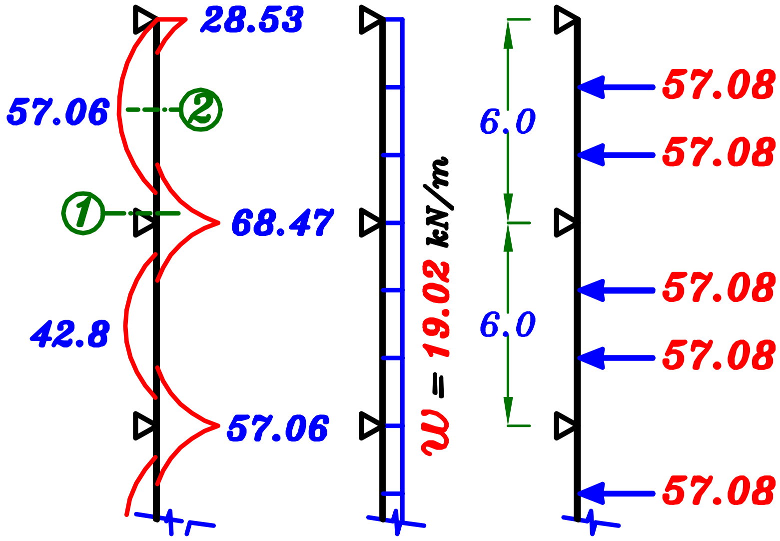


$$R_{VL.} = 64.09 * 6.0 + 171.28$$

$$\boxed{R_{VL.} = 555.82\ kN}$$

HL. Beam.

$$w = \frac{2 * 57.08}{6.0} = 19.02 \ kN/m$$



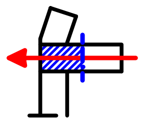
Reaction of HL. Beam.

$$R_{HL.} = 19.02 * 6.0 + 57.08$$

$$\boxed{R_{HL.} = 171.2 \ kN}$$

Sec. 1

$M_{U.L.} = 68.47$ kN.m R-sec.



Take $C_1 = 3.50 \rightarrow J = 0.78$

$$d = 3.50 \sqrt{\frac{68.47 * 10^6}{25 * 250}} \rightarrow d = 366.3 \ mm \quad \boxed{d = 400 \ mm} \quad \boxed{t = 450 \ mm}$$

$$A_s = \frac{68.47 * 10^6}{0.780 * 400 * 366.3} = 599.1 \ mm^2$$

Check $A_{s_{min.}}$ $\qquad A_{s_{req.}} = 599.1 \ mm^2$

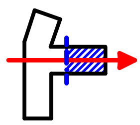
$$\mu_{min.}\, b\, d = \left(0.225 * \frac{\sqrt{F_{cu}}}{F_y}\right) b\, d = \left(0.225 * \frac{\sqrt{25}}{400}\right) 250 * 400 = 281.2 \ mm^2$$

$$\therefore A_{s_{req.}} > \mu_{min.}\, b\, d \quad \therefore \text{Take } A_s = A_{s_{req.}} = 599.1 \ mm^2$$

3 Φ16

Sec. 2

$M_{U.L.} = 57.06$ kN.m R-sec.



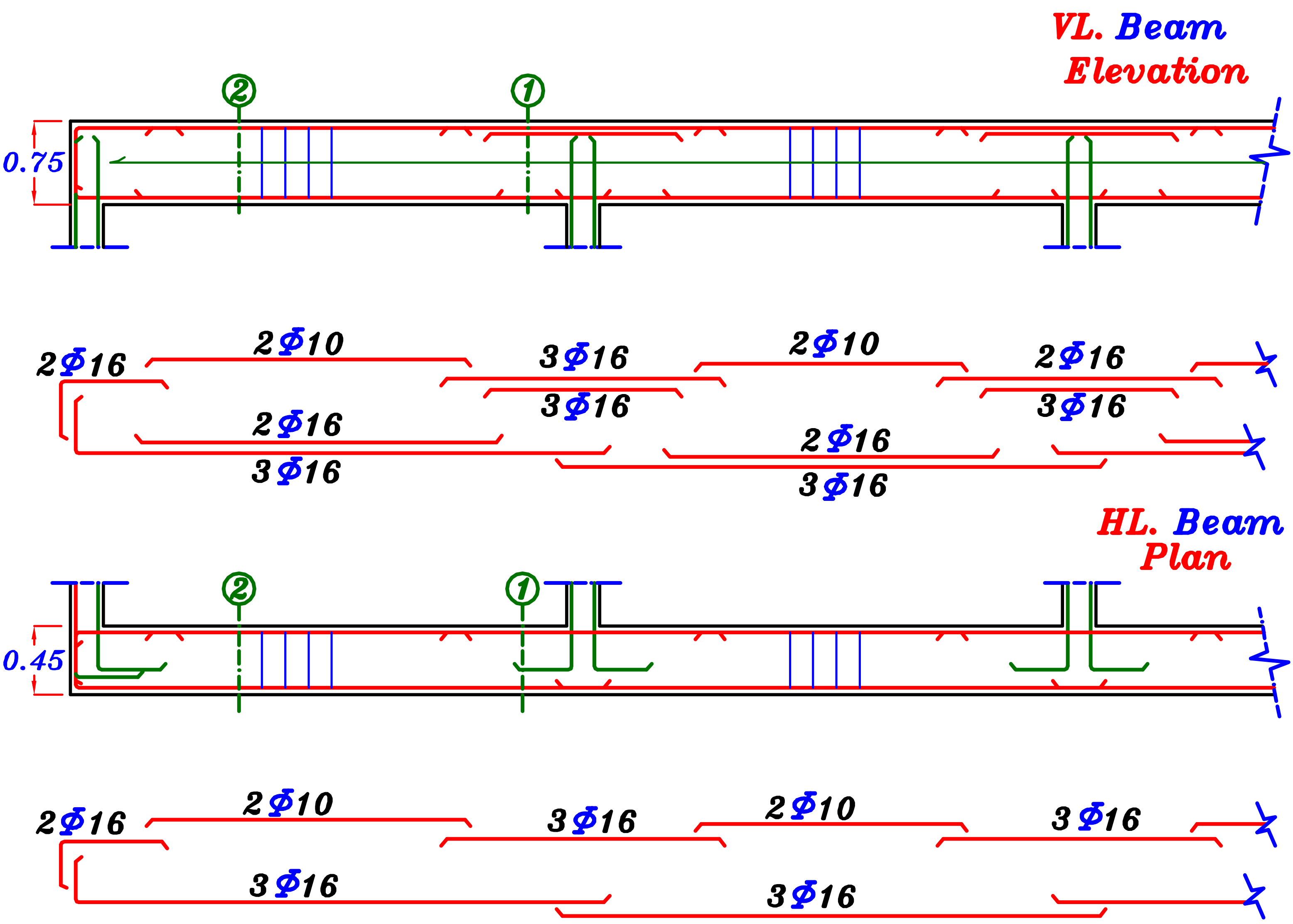
$$350 = C_1 \sqrt{\frac{57.06 * 10^6}{25 * 250}} \rightarrow C_1 = 4.18 \rightarrow J = 0.809$$

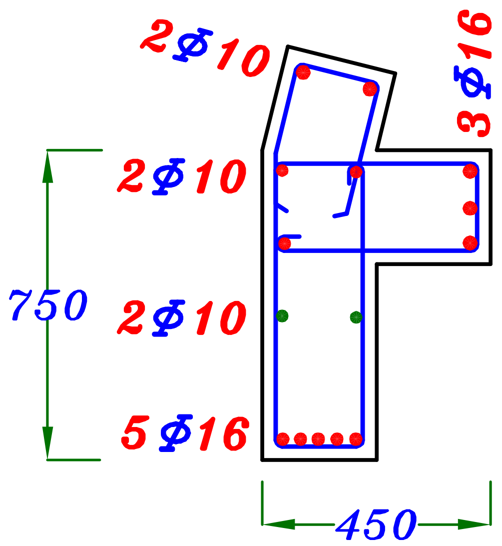
$$A_s = \frac{57.06 * 10^6}{0.826 * 400 * 400} = 440.8 \ mm^2 > \mu_{min.}\, b\, d$$

$$A_s = 440.8$$

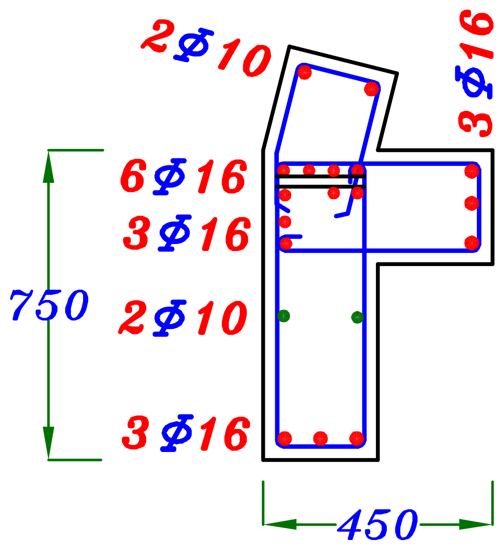
3 Φ16

RFT. of End Beam E





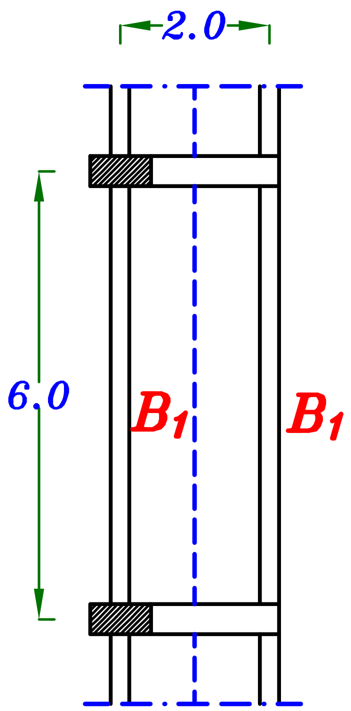
Sec. (2–2)



Sec. (1–1)

5- Design the main supporting element (*ABC*) and draw its details of reinforcement in elevation to scale 1:50 and cross sections to scale 1:10.

B_1



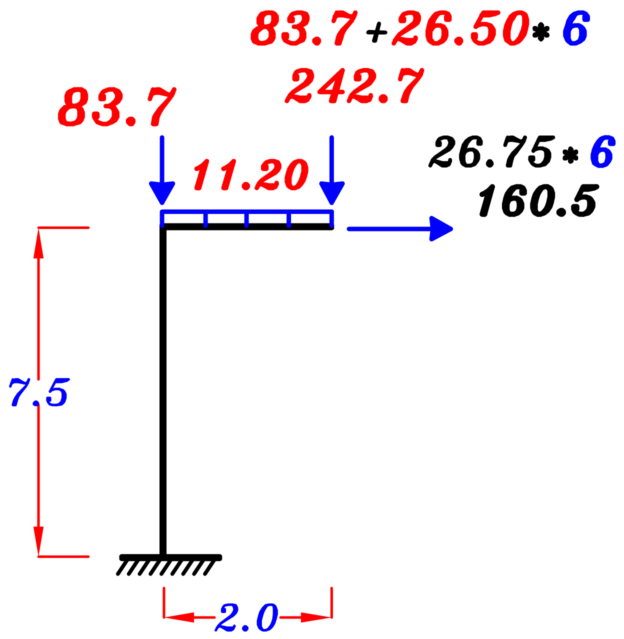
$$w_a = o.w. + w_s \frac{L_s}{2}$$

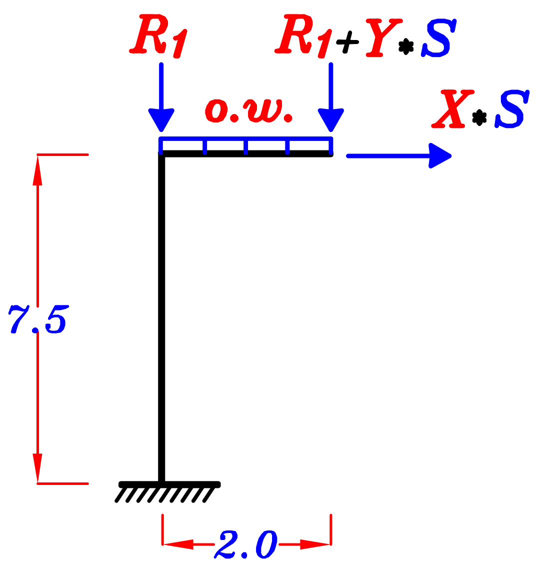
$$= 4.20 + (9.75)\left(\frac{2.0}{2}\right) = 13.95 \ kN \backslash m'$$

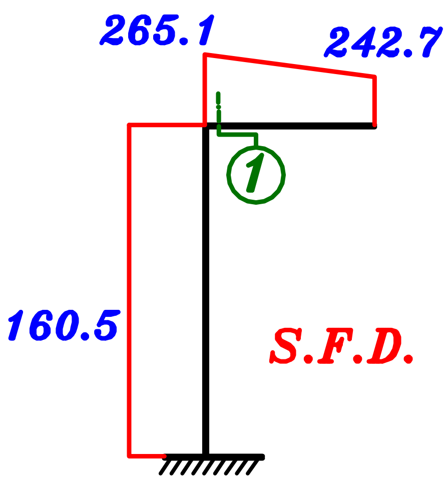
$$R_1 = 13.95 * 6.0 = 83.7 \ kN \qquad \boxed{R_1 = 83.7 \ kN}$$

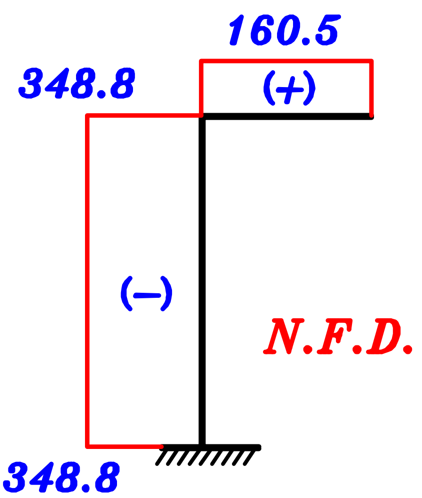
Frame (*ABC*) (400 * 800)

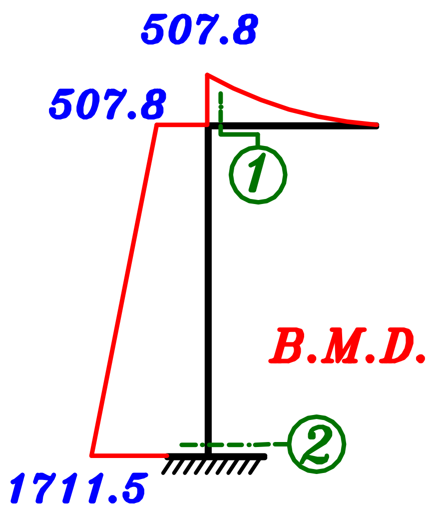
$$o.w. = 1.4 * 0.4 * 0.8 * 25 = 11.20 \ kN/m$$











Sec. ①

$M_{U.L.} = 507.8$ kN.m $\quad T_{U.L.} = 160.5$ kN.m $\quad (400 * 800)$

$$e = \frac{M}{T} = \frac{507.8}{160.5} = 3.16\ m \qquad \therefore \frac{e}{t} = \frac{3.16}{0.80} = 3.95 > 0.5 \xrightarrow{Use} e_s$$

$$e_s = e - \frac{t}{2} + c = 3.16 - \frac{0.80}{2} + 0.05 = 2.81\ m$$

$$M_s = T * e_s = 160.5 * 2.81 = 451.0 \quad kN.m$$

$$\therefore d = C_1 \sqrt{\frac{M_s}{F_{cu}\, b}} \quad \therefore 750 = C_1 \sqrt{\frac{451.0 * 10^6}{25 * 400}} \rightarrow C_1 = 3.53 \rightarrow J = 0.782$$

$$\therefore A_s = \frac{M_s}{J\, F_y\, d} + \frac{T_{U.L.}}{(F_y \backslash \delta_s)} = \frac{451.0 * 10^6}{0.782 * 400 * 750} + \frac{160.5 * 10^3}{(400 \backslash 1.15)}$$

$$= 2383.8\ mm^2$$

Check $A_{s\,min.}$ $\qquad A_{s_{req.}} = 2383.8\ mm^2$

$$\mu_{min.}\, b\, d = \left(0.225 * \frac{\sqrt{F_{cu}}}{F_y}\right) b\, d = \left(0.225 * \frac{\sqrt{25}}{400}\right) 400 * 750 = 843.7\ mm^2$$

$$\therefore A_{s_{req.}} > \mu_{min.}\, b\, d \quad \therefore Take\ A_s = A_{s_{req.}} = 2383.8\ mm^2 \qquad 7\,\Phi 22$$

$$\therefore n = \frac{b - 25}{\phi + 25} = \frac{400 - 25}{22 + 25} = 7.97 = 7.0\ bars$$

Sec. ②

$M_{U.L.} = 1711.5$ kN.m $\quad P_{U.L.} = 348.8$ kN.m $\quad (400 * 800)$

$$Check \quad \frac{P}{F_{cu}\, b\, t} = \frac{348.8 * 10^3}{25 * 400 * 800} = 0.043 > 0.04 \quad (Don't\ Neglect\ P)$$

$$e = \frac{M}{P} = \frac{1711.5}{348.8} = 4.906\ m \qquad \therefore \frac{e}{t} = \frac{4.906}{0.80} = 6.13 > 0.5 \xrightarrow{Use} e_s$$

$$e_s = e - \frac{t}{2} + c = 4.906 + \frac{0.80}{2} - 0.05 = 5.256\ m$$

$$M_s = P * e_s = 348.8 * 5.256 = 1833.3\ kN.m$$

$$\therefore d = C_1 \sqrt{\frac{M_S}{F_{cu}\, b}} \qquad \therefore 750 = C_1 \sqrt{\frac{1833.3 * 10^6}{25 * 400}} \rightarrow C_1 = 1.75 < 2.78$$

$\therefore$ The section is over reinforced

$\therefore$ Increase depth or use $A_{S`}$ From I.D.

IF we use $A_{S`}$ From I.D.

$$\zeta = \frac{800 - 100}{800} = 0.87 = 0.80 \xrightarrow{use} \text{ECCS Design Aids Page } 4\text{–}21$$

$$\frac{P_U}{F_{cu}\, b\, t} = \frac{348.8 * 10^3}{25 * 400 * 800} = 0.043$$

$$\frac{M_U}{F_{cu}\, b\, t^2} = \frac{1711.5 * 10^6}{25 * 400 * 800^2} = 0.267$$

$$\Bigg\} \; \rho = 8.80$$

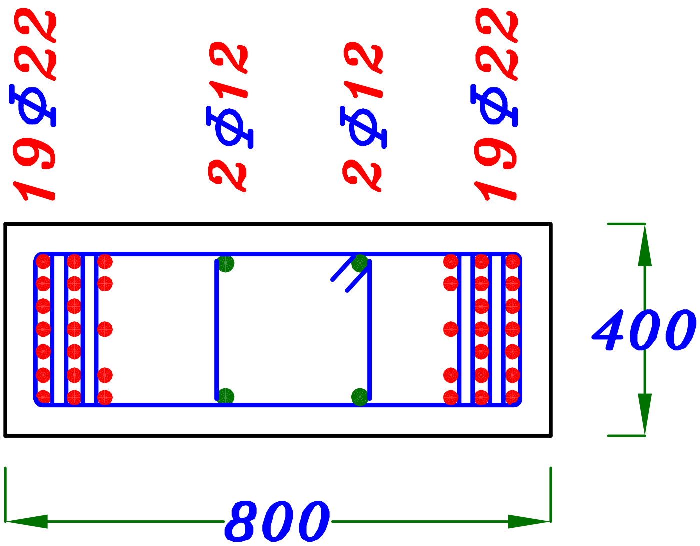
$$\mu = \rho * F_{cu} * 10^{-4} = 8.80 * 25 * 10^{-4} = 0.022$$

$$A_S = A_{S`} = \mu * b * t = 0.022 * 400 * 800 = 7040 \text{ mm}^2$$

– Check $A_{S_{min.}} = \frac{0.8}{100} * b * t = \frac{0.8}{100} * 400 * 800 = 2560 \text{ mm}^2$

$A_{S_{Total}} = A_S + A_{S`} = 2 * 7040 = 14080 \text{ mm}^2 \quad \therefore A_{S_{Total}} > A_{S_{min.}}$

$\therefore$ take $A_S = A_{S`} = \frac{A_{S\,Total}}{2} = 7040 \text{ mm}^2$ 19 ϕ22



Sec. (2–2)

Too Expensive

$\therefore$ Better to Increase depth instead of using I.D.

$\therefore$ Increase depth instead of using I.D.

To choose minimum depth that make the section under reinforced

Take $C_1 = 2.78$

$$\therefore\ d = C_1 \sqrt{\frac{M_s}{F_{cu}\, b}} = 2.78 \sqrt{\frac{1833.3 * 10^6}{25 * 400}} = 1190.3 \text{ mm}$$

$\therefore$ Choose $\boxed{d = 1200 \text{ mm}}$, $\boxed{t = 1300 \text{ mm}}$

$$\text{Check}\quad \frac{P}{F_{cu}\, b\, t} = \frac{348.8 * 10^3}{25 * 400 * 1300} = 0.0268 < 0.04 \quad (\text{Neglect } P)$$

$$\therefore\ d = C_1 \sqrt{\frac{M}{F_{cu}\, b}} \quad \therefore\ 1200 = C_1 \sqrt{\frac{1711.5 * 10^6}{25 * 400}} \rightarrow C_1 = 2.90 \rightarrow J = 0.732$$

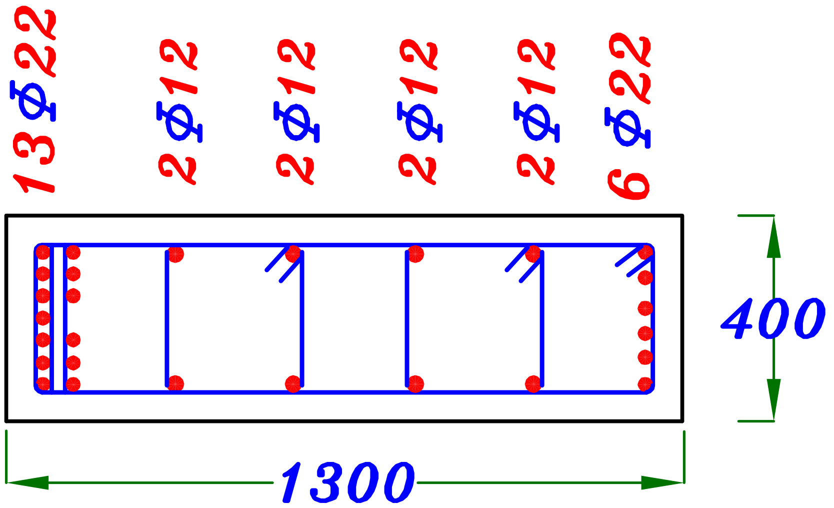
$$\therefore\ A_s = \frac{M_{U.L.}}{J\, F_y\, d} = \frac{1711.5 * 10^6}{0.732 * 400 * 1200} = 4871.07 \text{ mm}^2$$

Check $A_{s\,min.}$ $\qquad A_{s_{req.}} = 4871.07 \text{ mm}^2$

$$\mu_{min.}\, b\, d = \left(0.225 * \frac{\sqrt{F_{cu}}}{F_y}\right) b\, d = \left(0.225 * \frac{\sqrt{25}}{400}\right) 400 * 1200 = 1350 \text{ mm}^2$$

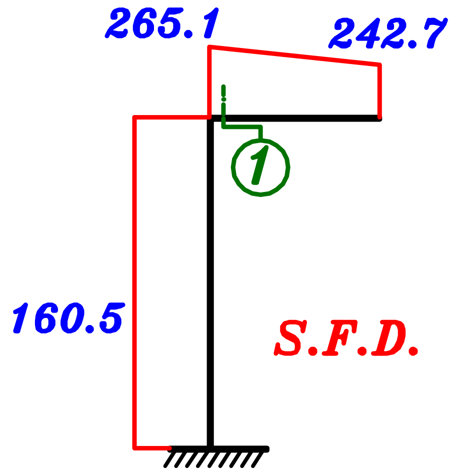
$\therefore\ A_{s_{req.}} > \mu_{min.}\, b\, d \quad \therefore$ Take $A_s = A_{s_{req.}} = 4871.07 \text{ mm}^2$ $\quad 13\phi22$

Stirrup Hangers $= (0.4)\ 4871.07$ $\quad 6\,\phi22$



Sec. (2–2)

Check Shear.



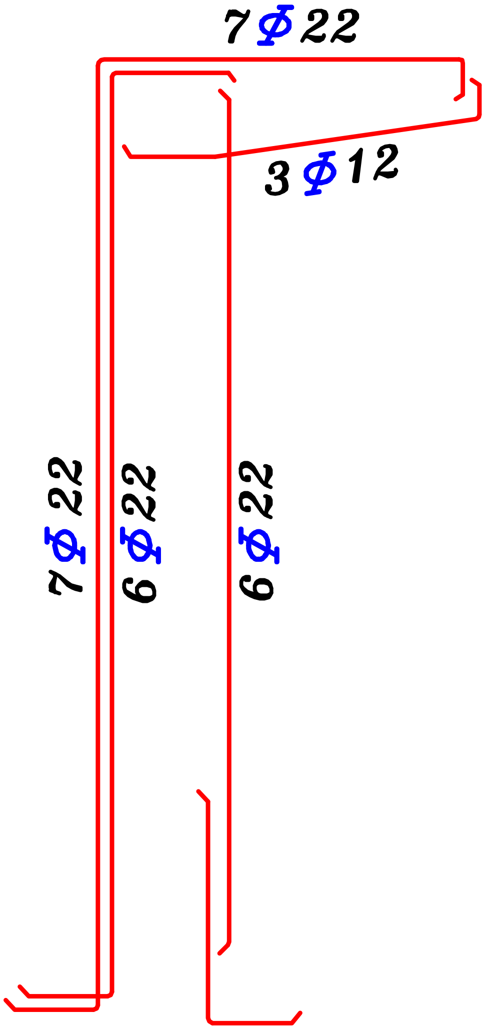
Sec. 1

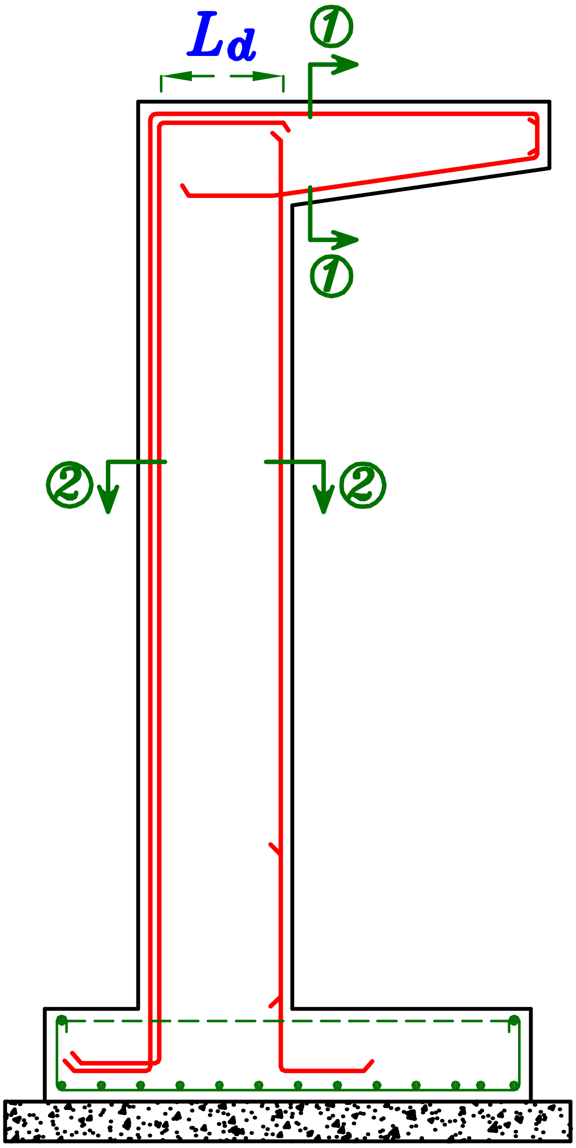
$$q_{cu} = (0.24)\sqrt{\frac{25}{1.50}} = 0.98 \quad N\backslash mm^2$$

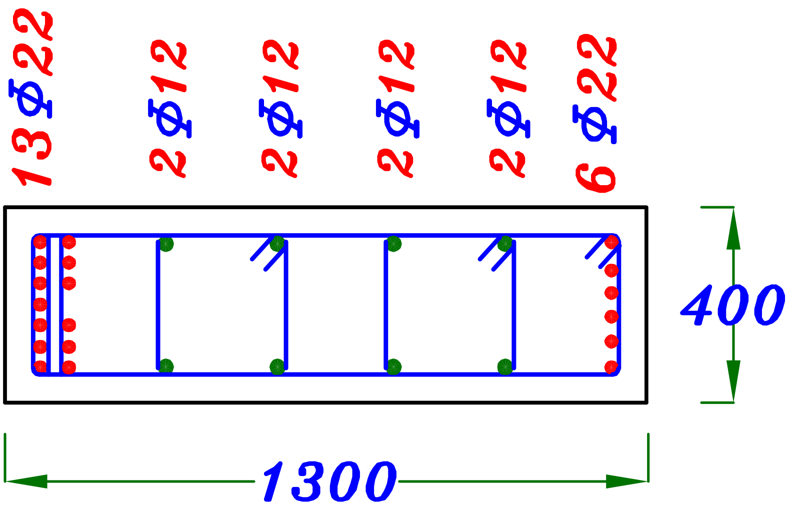
$$q_{u_{max}} = (0.70)\sqrt{\frac{25}{1.50}} = 2.85 \quad N\backslash mm^2$$

$$q_u = \frac{Q_{max}}{b\,d} = \frac{265.1 * 10^3}{400 * 750} = 0.883 \quad N\backslash mm^2$$

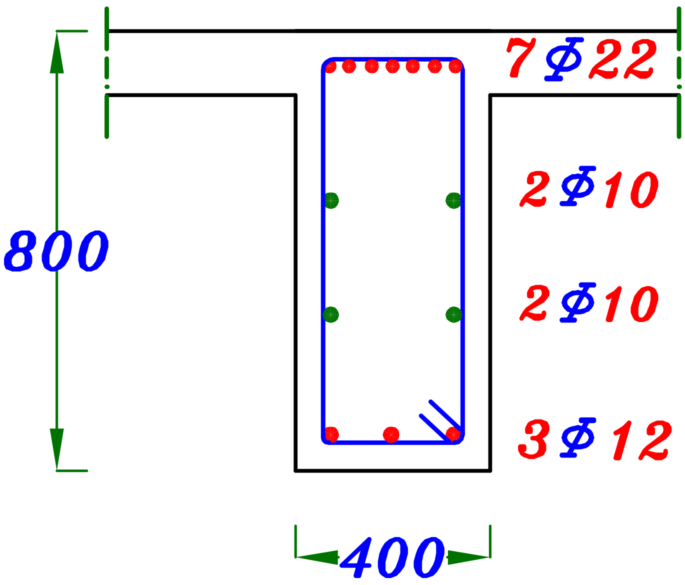
$\therefore\ q_u < q_{cu}$ $\therefore$ We need Stirrups more Than $5\phi 8 \backslash m'$


7Φ22
3Φ12
7Φ22
6Φ22
6Φ22


Ld
①
①
②
②

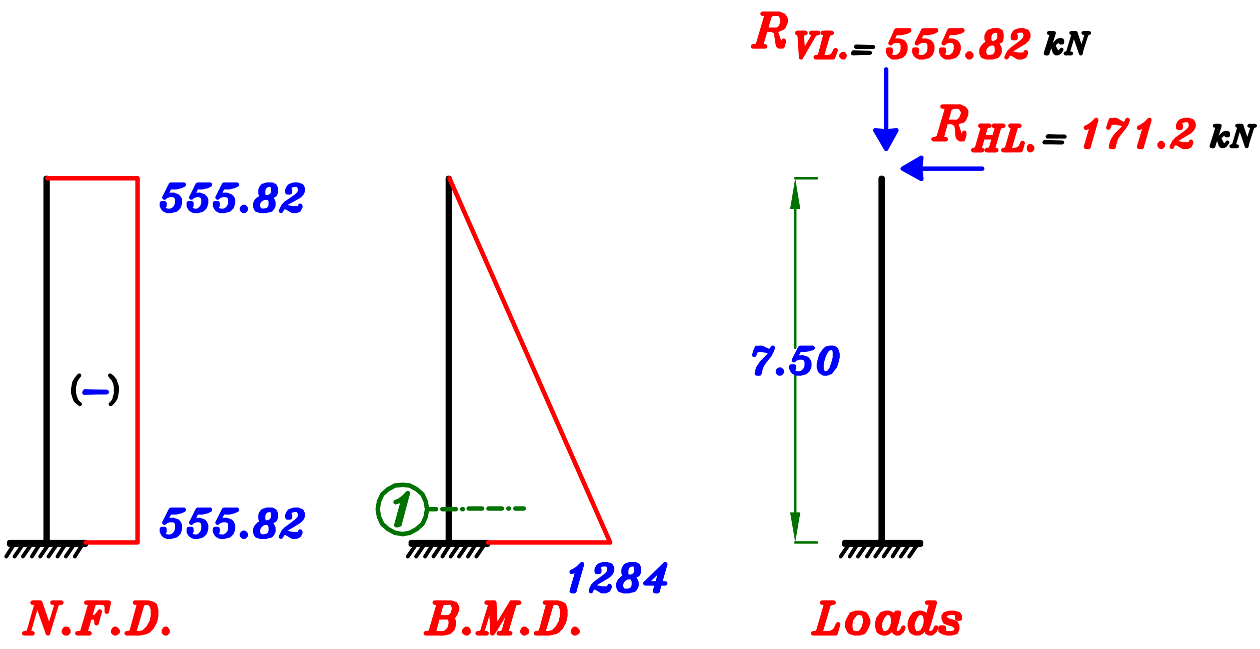

13Φ22
2Φ12
2Φ12
2Φ12
2Φ12
6Φ22
400
1300

Sec. (2-2)


7Φ22
2Φ10
2Φ10
3Φ12
800
400

Sec. (1-1)

6- Design the column (EF) and draw its details of reinforcement in cross section 1:10 .



Sec. 1 $M_{U.L.} = 1284$ kN.m $P_{U.L.} = 555.82$ kN.m $(400 * 1300)$

Check $\frac{P}{F_{cu}\, b\, t} = \frac{555.82 * 10^3}{25 * 400 * 1300} = 0.042 > 0.04$ (Don't Neglect P)

$e = \frac{M}{P} = \frac{1284}{555.82} = 2.31$ m $\therefore \frac{e}{t} = \frac{2.31}{1.30} = 1.77 > 0.5 \xrightarrow{Use} e_s$

$e_s = e - \frac{t}{2} + c = 2.31 + \frac{1.30}{2} - 0.10 = 2.86$ m

$M_s = P * e_s = 555.82 * 2.86 = 1589.64$ kN.m

$\therefore d = C_1 \sqrt{\frac{M_s}{F_{cu}\, b}}$ $\therefore 1200 = C_1 \sqrt{\frac{1589.64 * 10^6}{25 * 400}} \rightarrow C_1 = 3.0 \rightarrow J = 0.743$

$\therefore A_s = \frac{M_s}{J\, F_y\, d} - \frac{P_{U.L.}}{(F_y \backslash \gamma_s)} = \frac{1589.64 * 10^6}{0.743 * 400 * 1200} - \frac{555.82 * 10^3}{(400 \backslash 1.15)}$

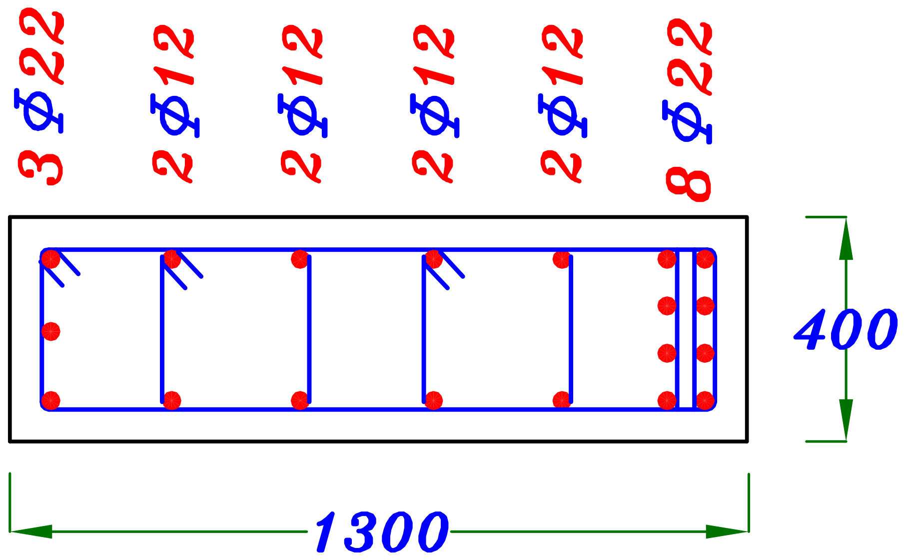
$= 2859.3 \ mm^2$

Check $A_{s\,min.}$ $\qquad A_{s_{req.}} = 2859.3 \; mm^2$

$$\mu_{min.}\, b\, d = \left(0.225 * \frac{\sqrt{F_{cu}}}{F_y}\right) b\, d = \left(0.225 * \frac{\sqrt{25}}{400}\right) 400 * 1200 = 1350 \; mm^2$$

$$\therefore A_{s_{req.}} > \mu_{min.}\, b\, d \quad \therefore \text{Take } A_s = A_{s_{req.}} = 2859.3 \; mm^2 \qquad 8\,\Phi 22$$

$$\text{Stirrup Hangers} = (0.4)\; 2859.3 \qquad 3\,\Phi 22$$

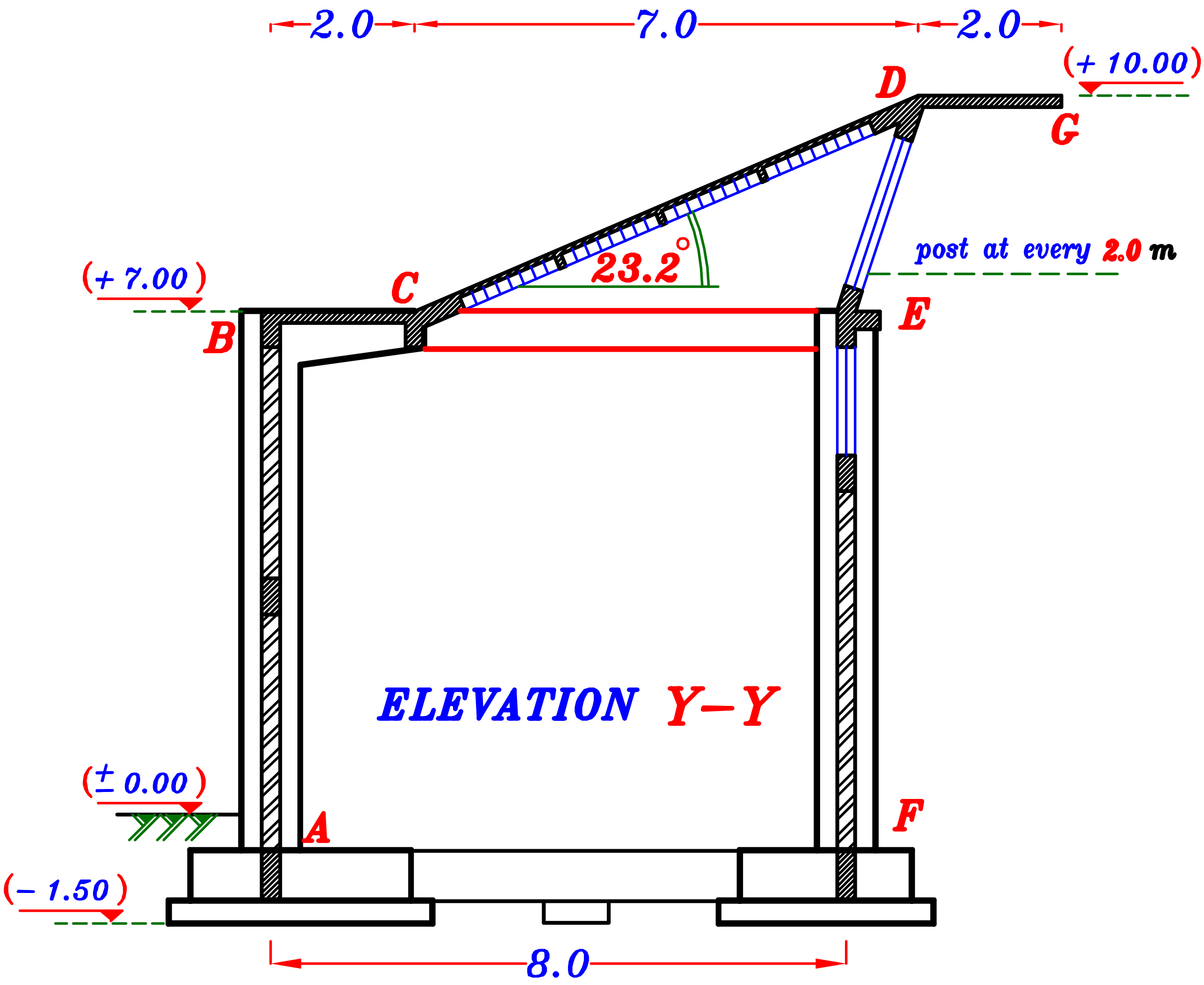


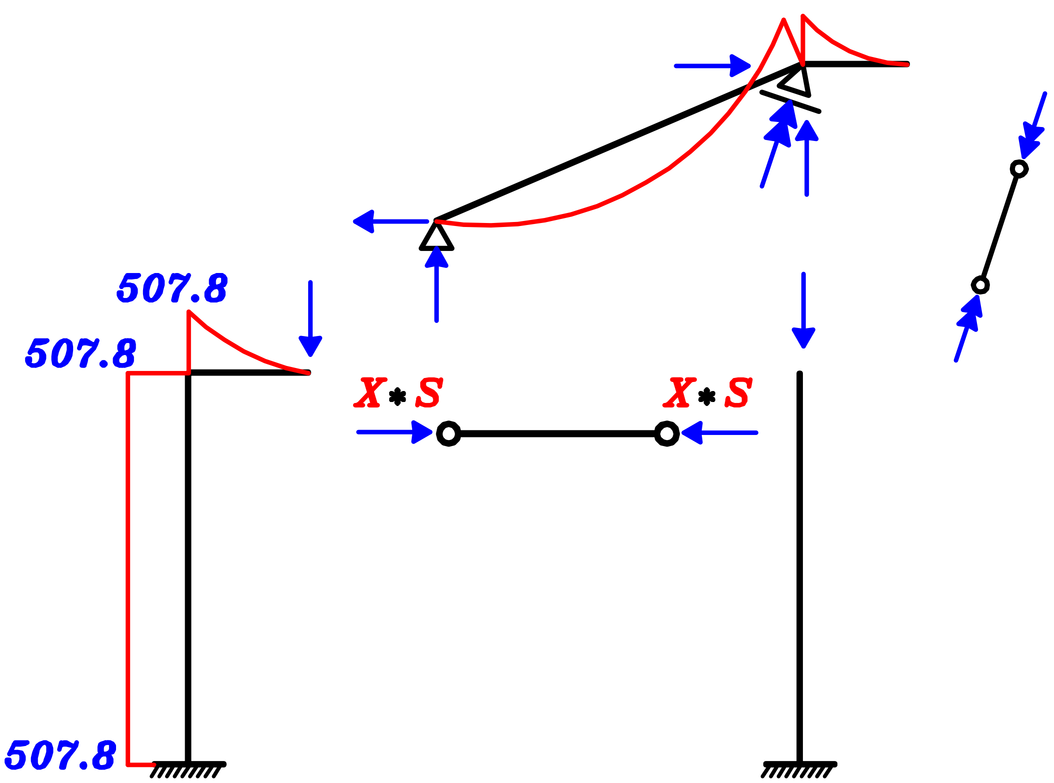
Sec. (1−1)

7-IF an element is added between Point C and E, perform the Following:

a-Draw Elevation Y-Y showing element (CE) with its minimum accepted dimensions. Show the eccentricity of the Footings at A and F.

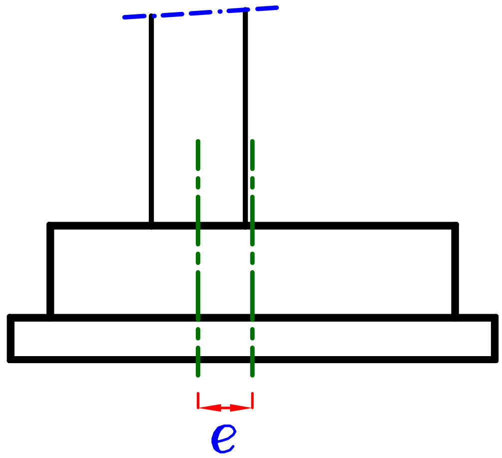
b-Design this element and draw its details of reinforcement in cross section.





Footing A

$$e = \frac{M}{Y} = \frac{507.8}{348.8} = 1.45 \ m$$



Footing F

$$e = Zero$$

Design of member (CE) (400 * 400)

Compression Force $= R_{HL.} = 87.66 \ kN$

Neglect the effect of buckling.

$$A_c = 400 * 400 = 160000 \ mm^2$$

$$\because P_{U.L.} = 0.35 \ A_c \ F_{cu} + 0.67 \ A_s \ F_y$$

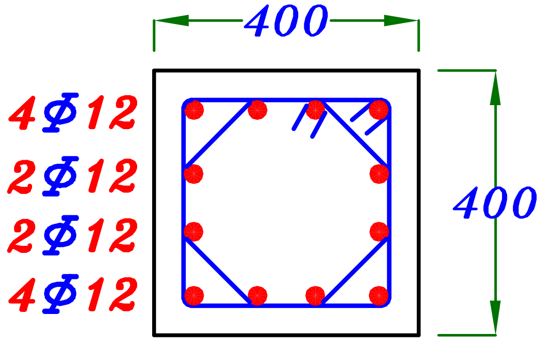
$$\therefore 160.5 * 10^3 = 0.35 \ (160000) \ (25) + 0.67 \ A_s \ (400)$$

$$\therefore A_s = -4625 \ mm^2$$

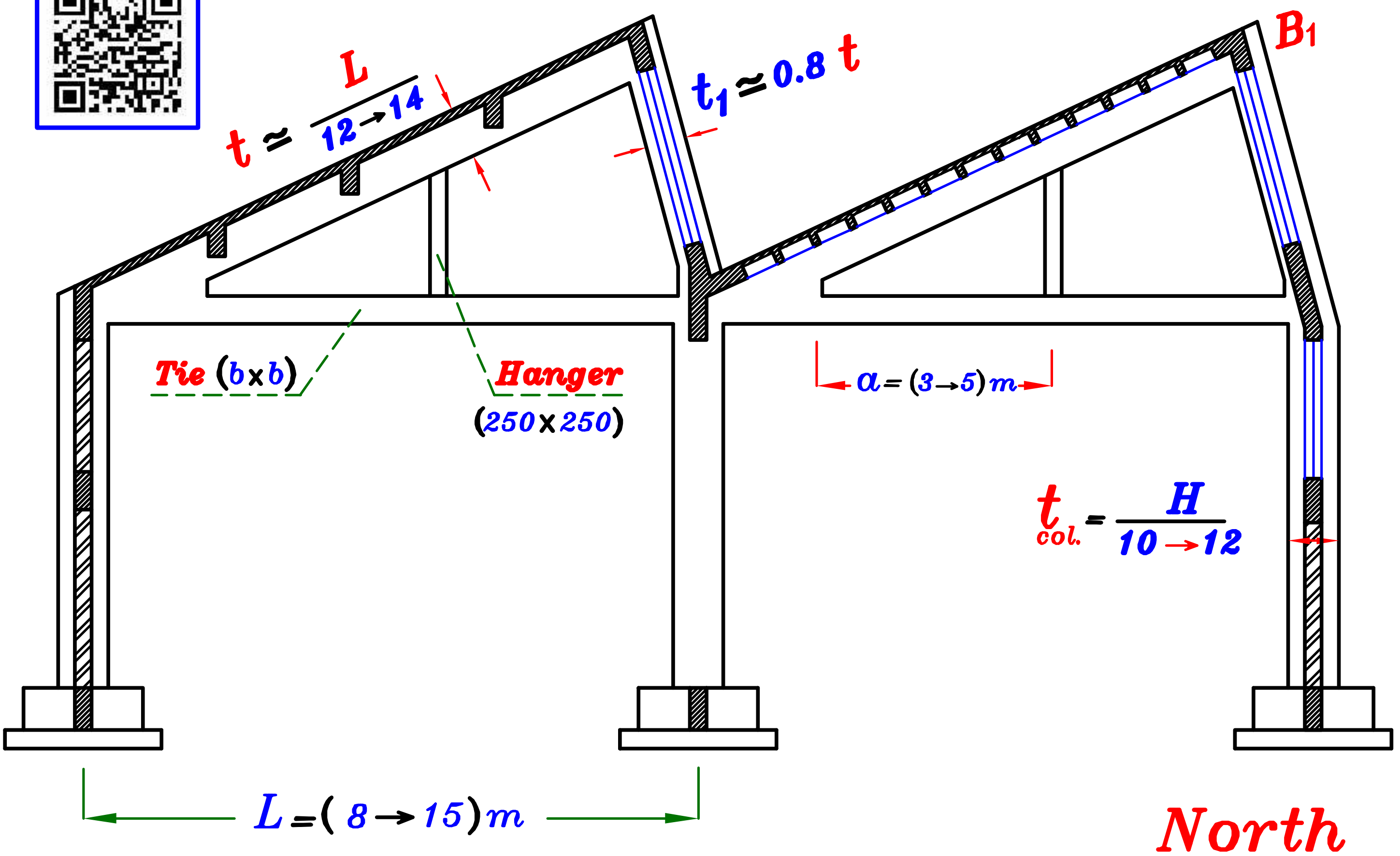
$$\therefore \mu = \frac{A_s}{A_c} = \frac{-4625}{160000} = -0.029 = -2.90 \ \% < 0.8 \ \%$$

$$\therefore \text{Take } \mu = 0.8 \ \% \longrightarrow A_s = \frac{0.8}{100} * 160000 = 1280 \ mm^2$$

$$\boxed{12 \ \phi \ 12}$$



Saw Tooth Girder Type.



North →

* Span $(L) = (8 \longrightarrow 15)\ m$

* $t_{(Girder)} \simeq \dfrac{L}{12 \rightarrow 14}$

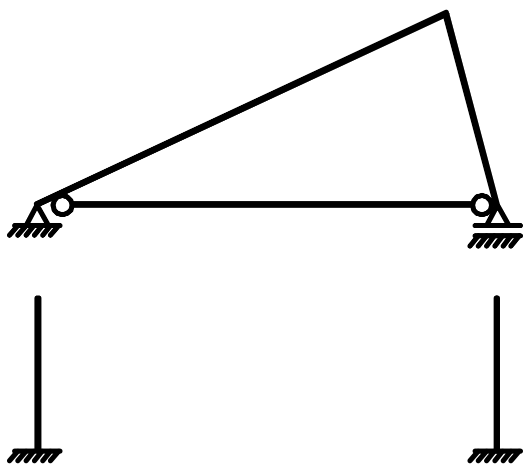
* $t_1 \simeq 0.8\ t$

* $b_{(Girder)} = \left.\begin{matrix} 0.30\ m \\ \dfrac{Spacing}{20} \end{matrix}\right\}$ الأكبر

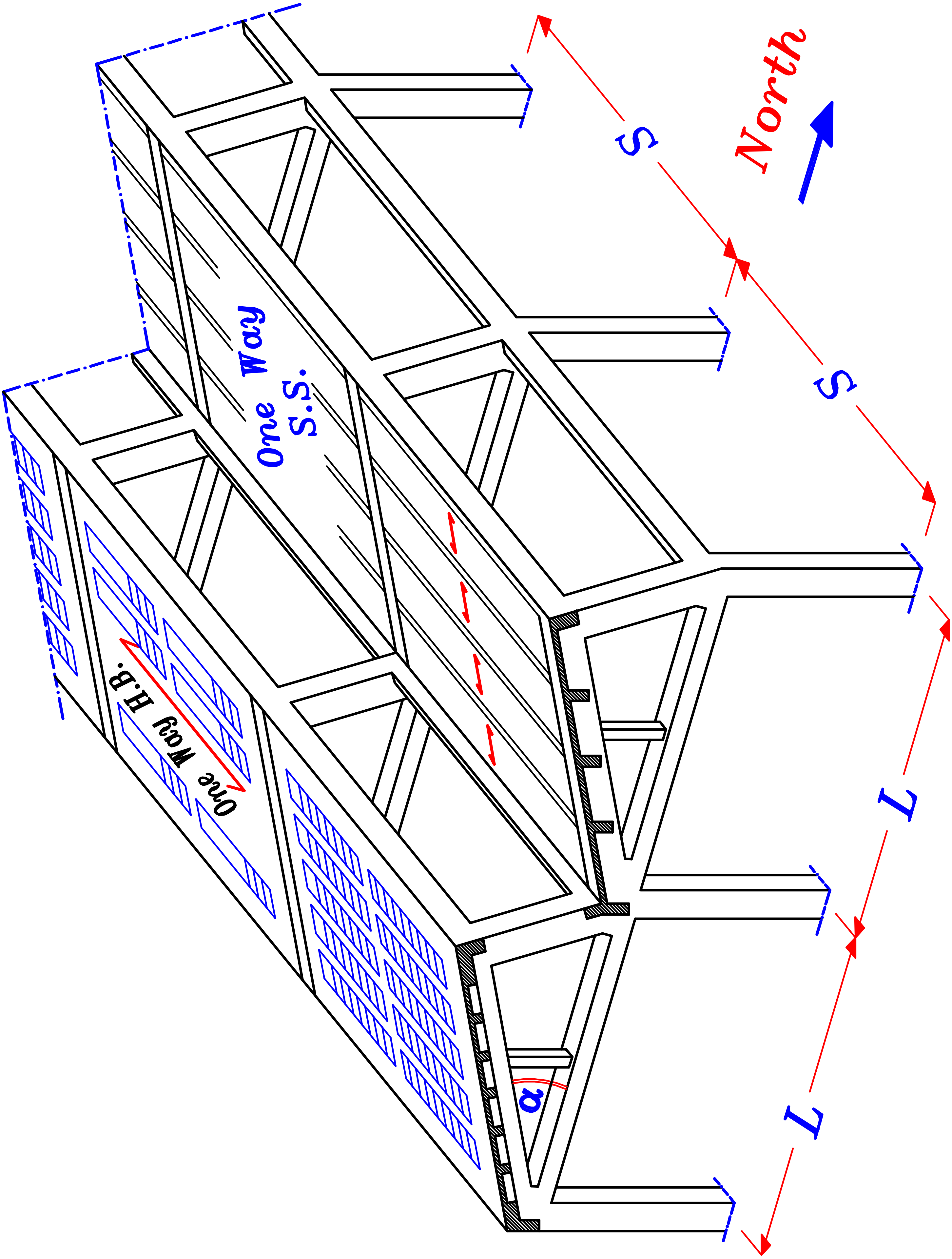
* Tie $(b \times b)$

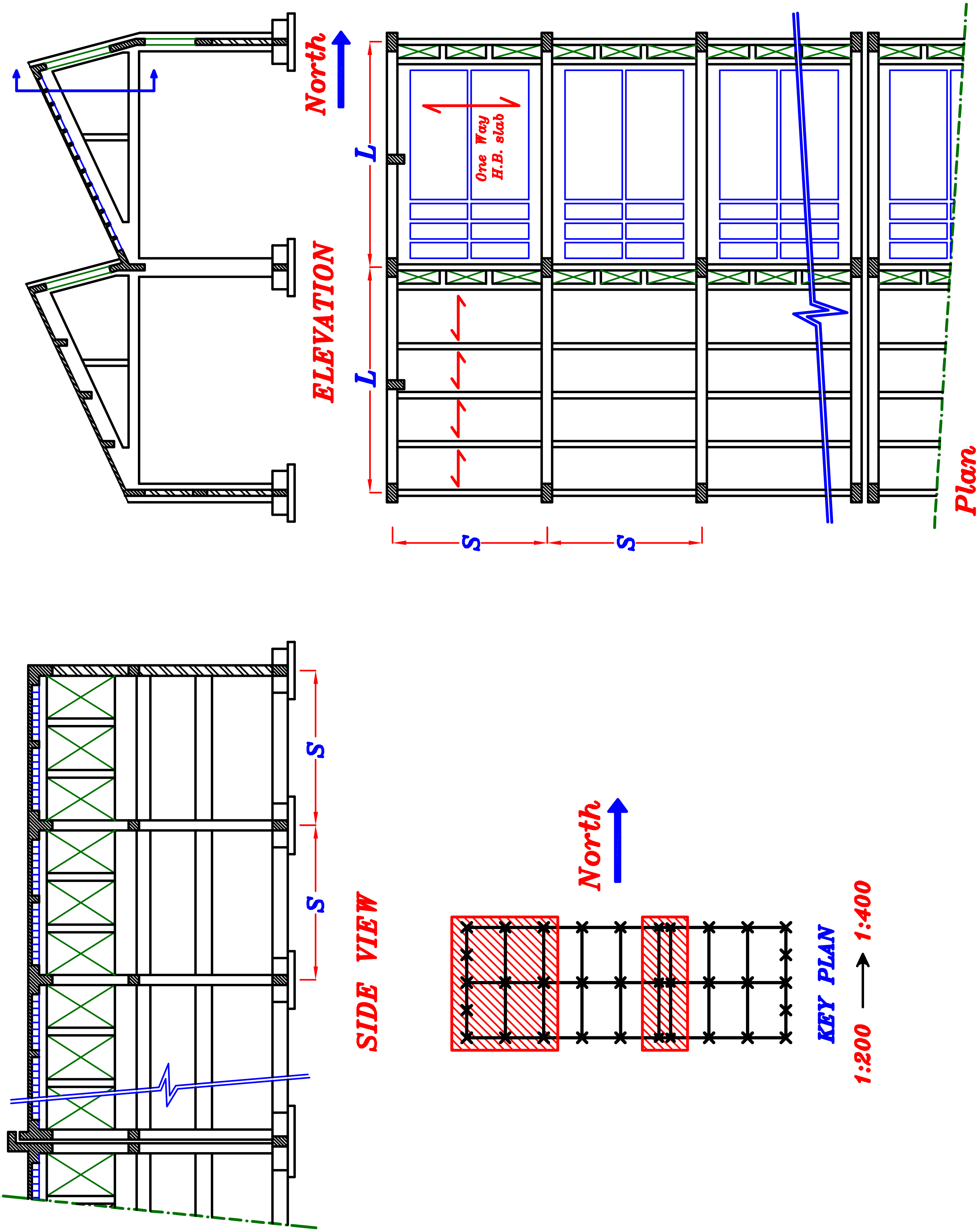
* Hanger (250×250)

* $t_{col.} = \dfrac{H}{10 \rightarrow 12}$

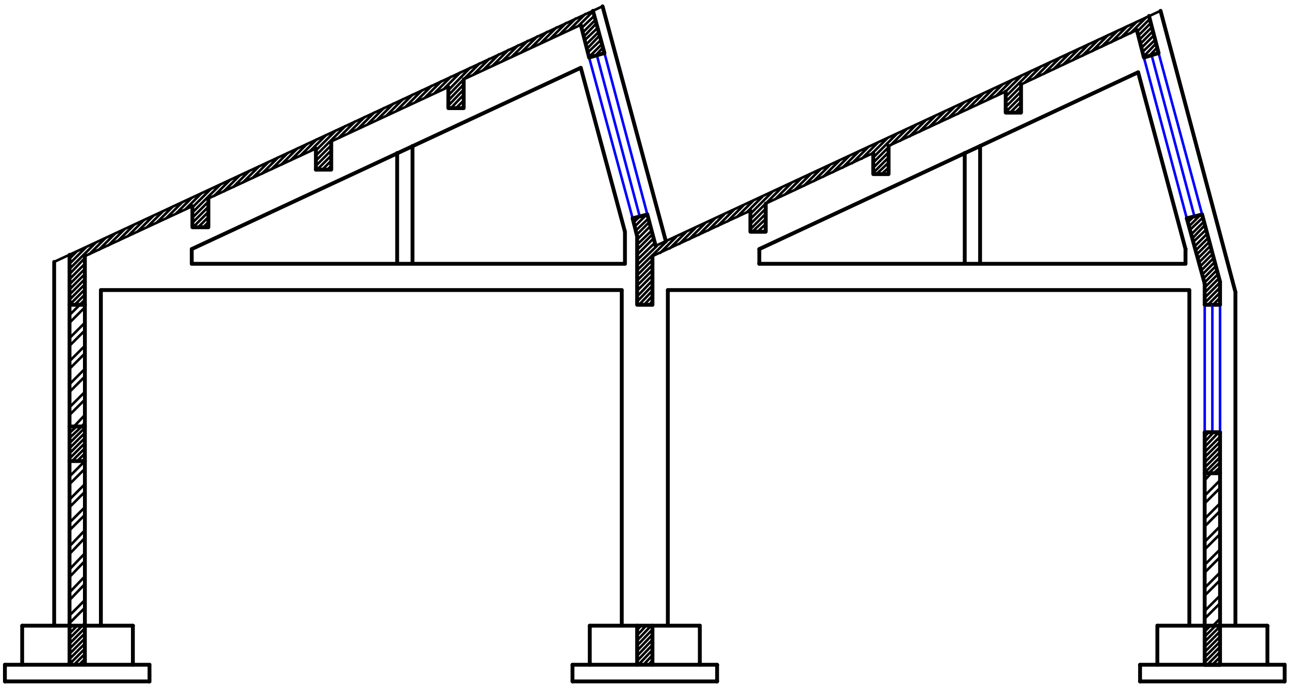


Statical System

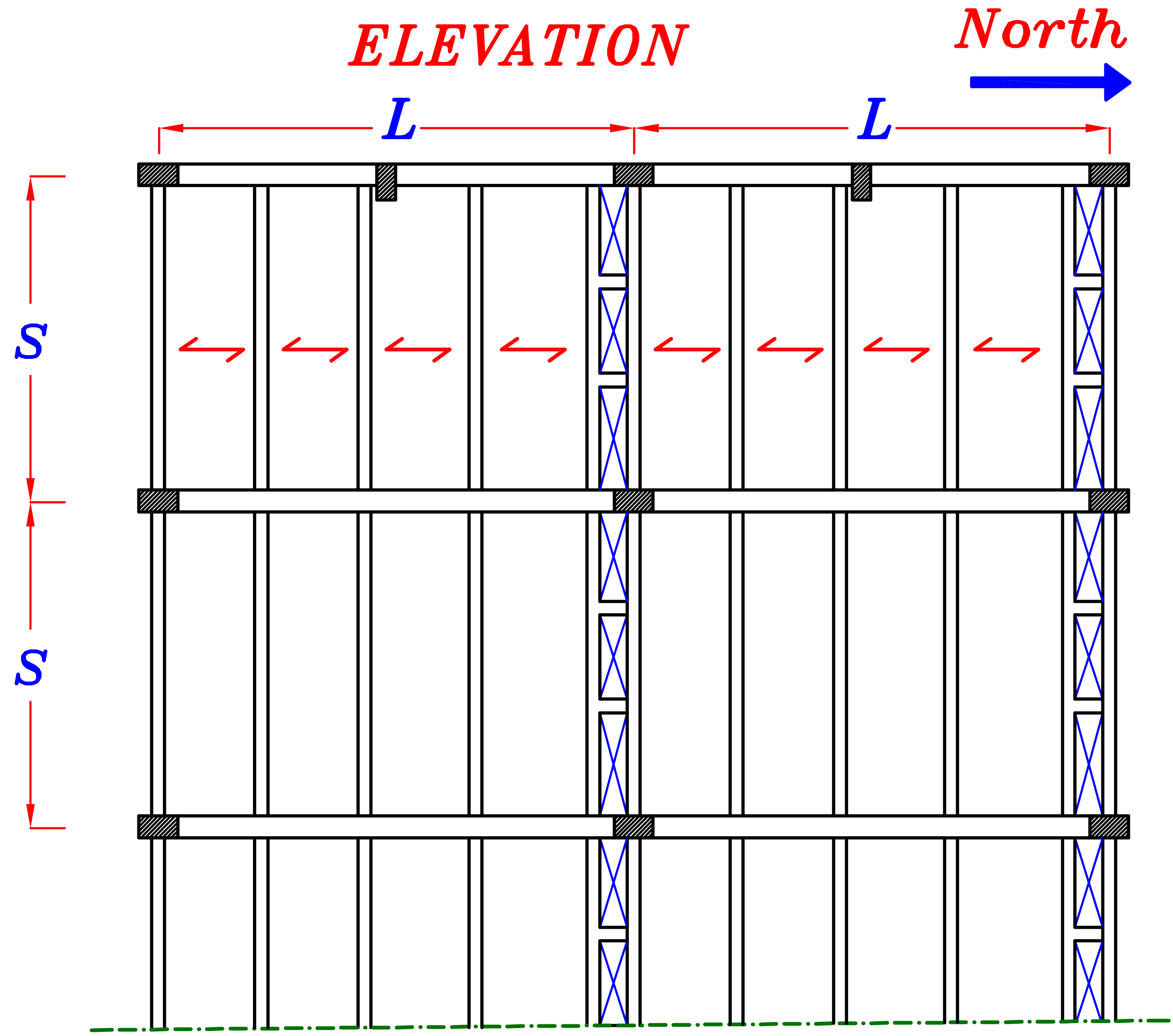

North
S
S
L
L
One Way
S.S.
One Way H.B.
α


North
ELEVATION
L
L
One Way
H.B. slab
S
S
Plan
SIDE VIEW
S
S
North
KEY PLAN
1:200 → 1:400

IF the Slabs are Solid Slabs.

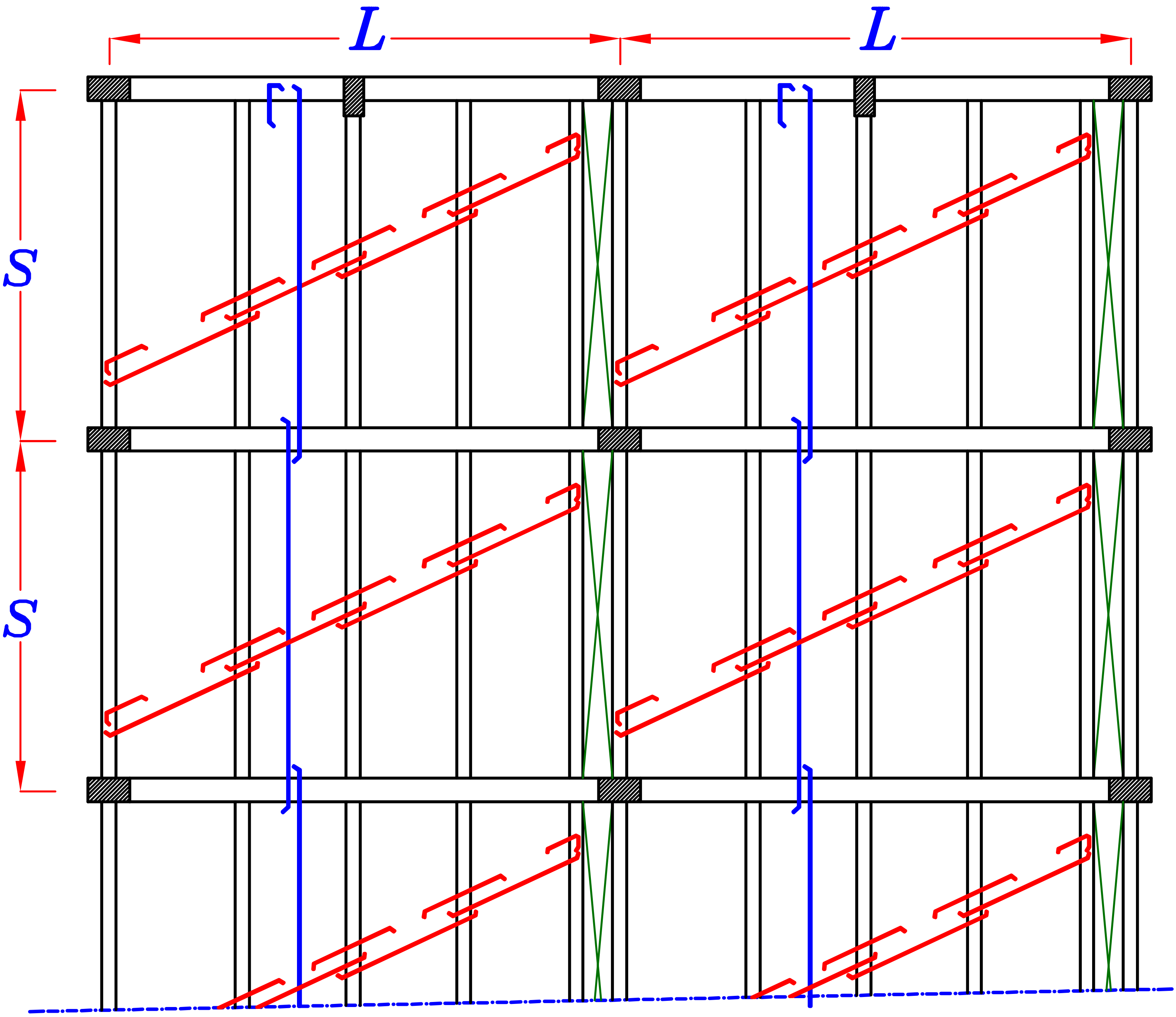


ELEVATION

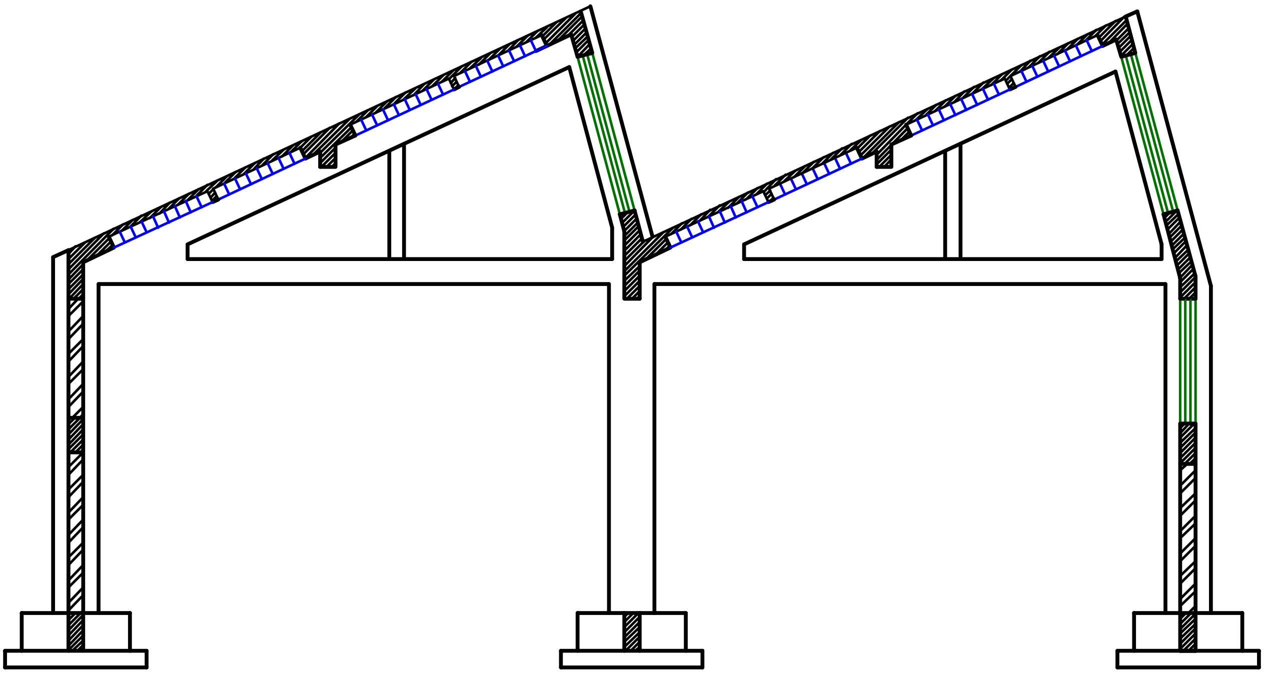


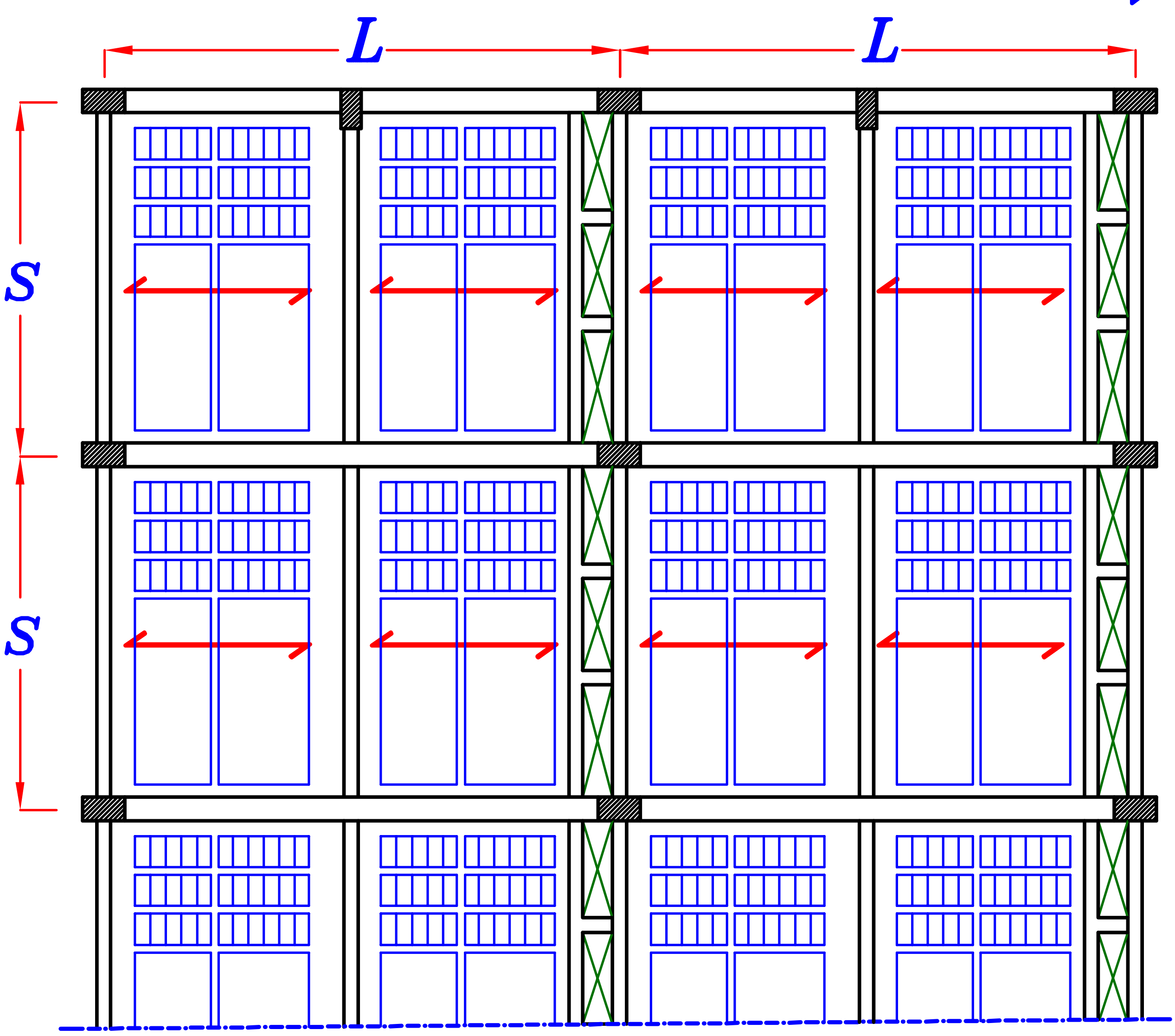
Plan

RFT. of the slab Solid Slab.

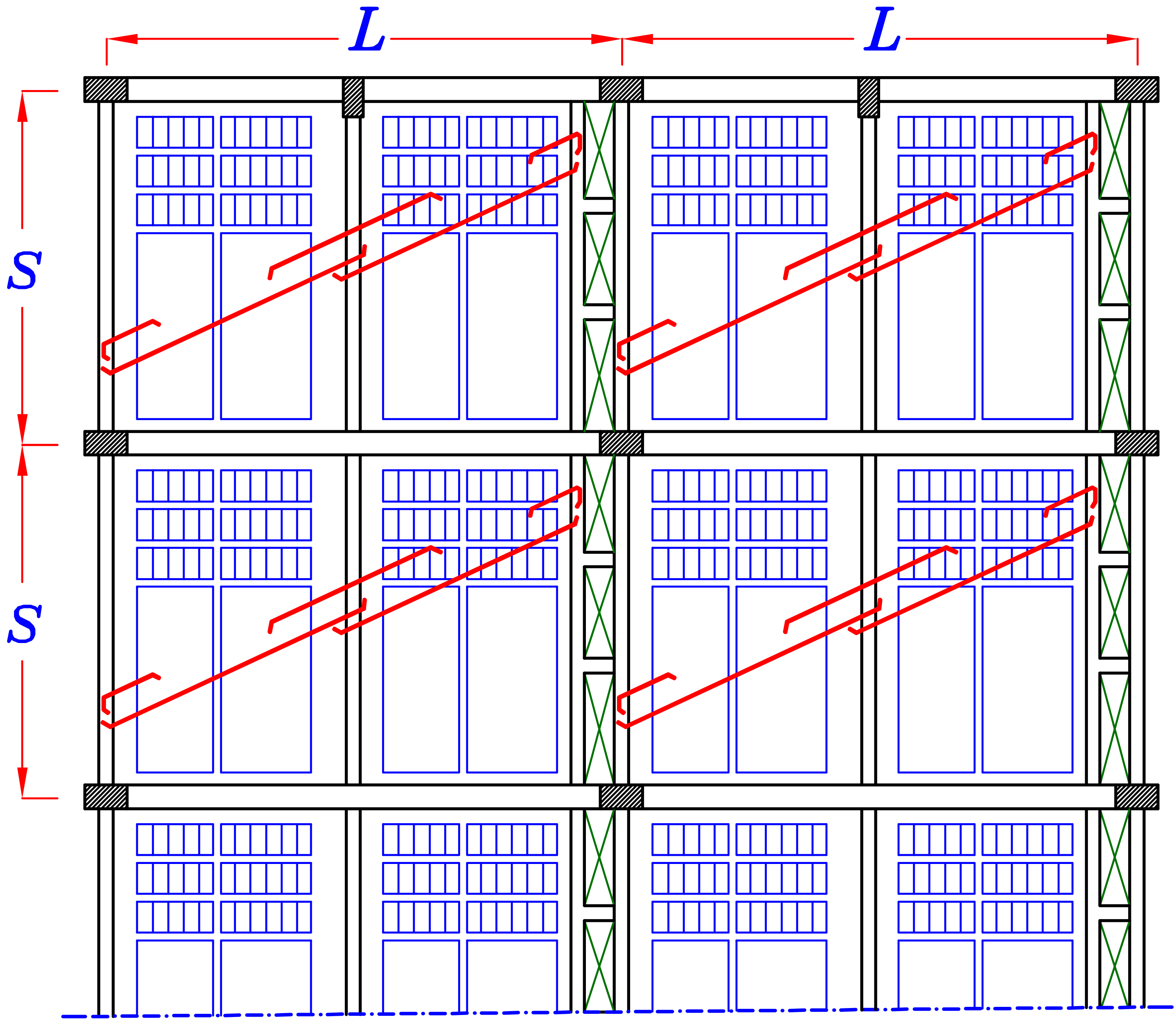


IF the Slabs are one way H.B. Slabs at beams direction.

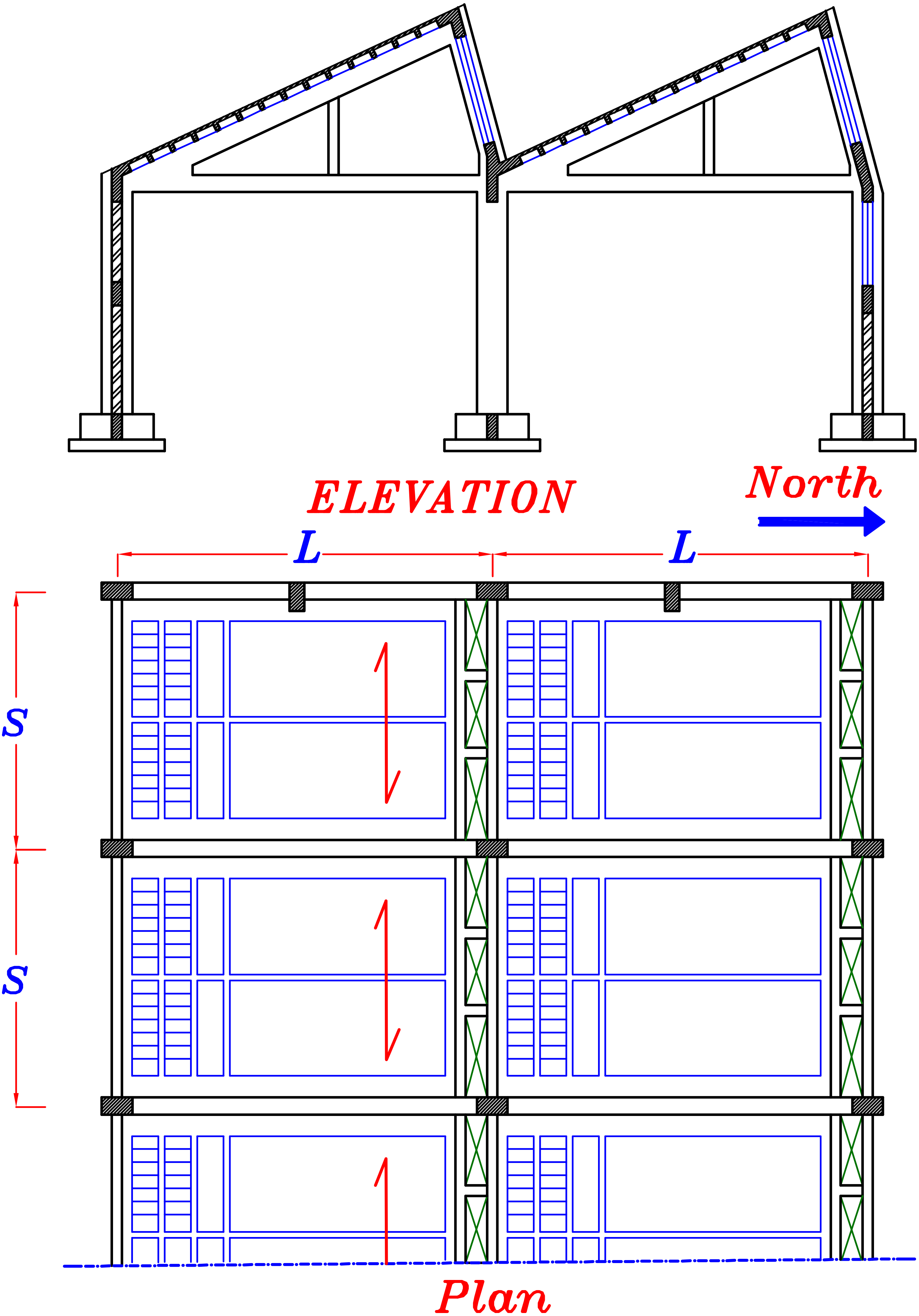




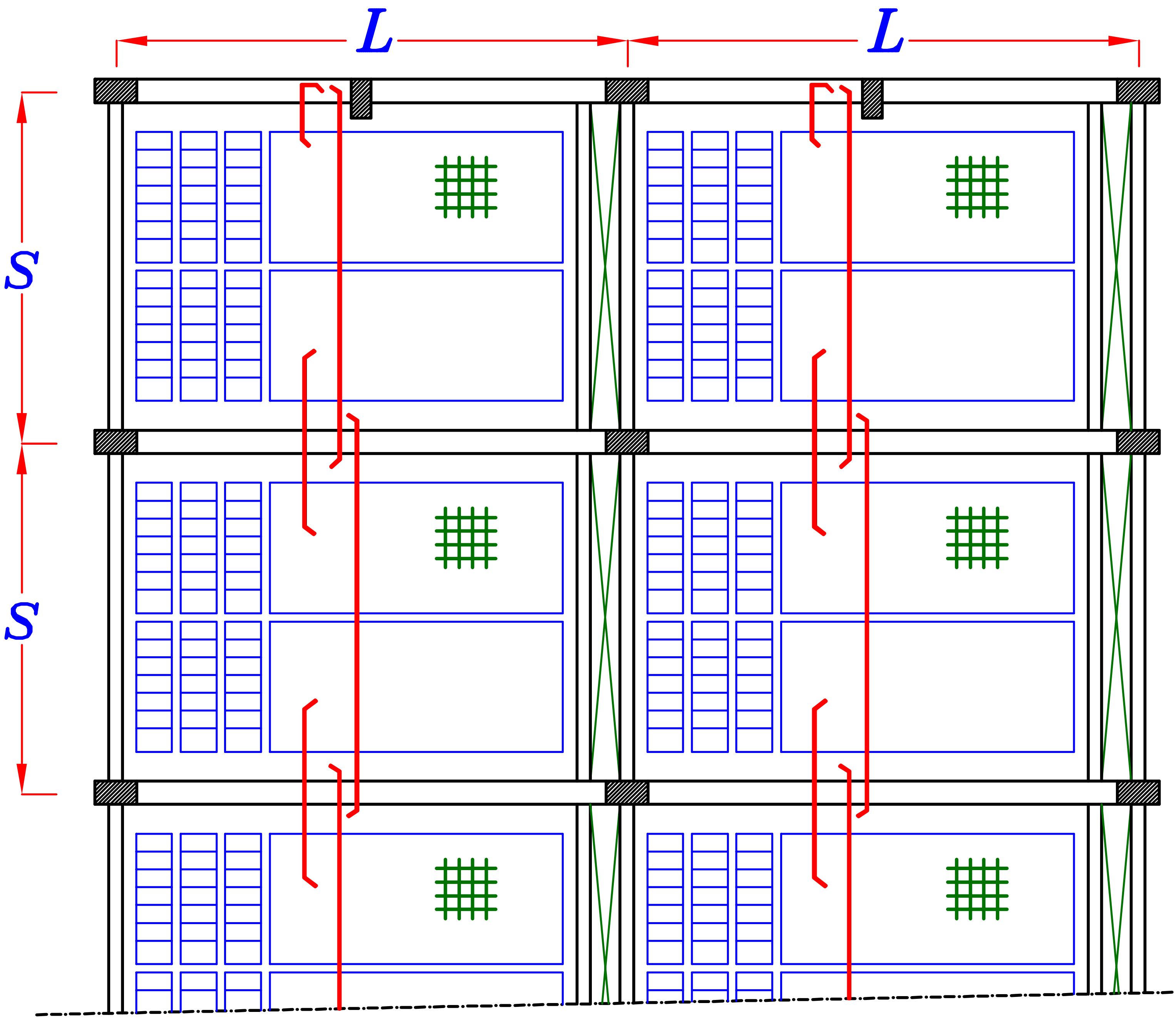
RFT. of the slab Solid Slab.



IF the Slabs are one way H.B. Slabs at system direction.



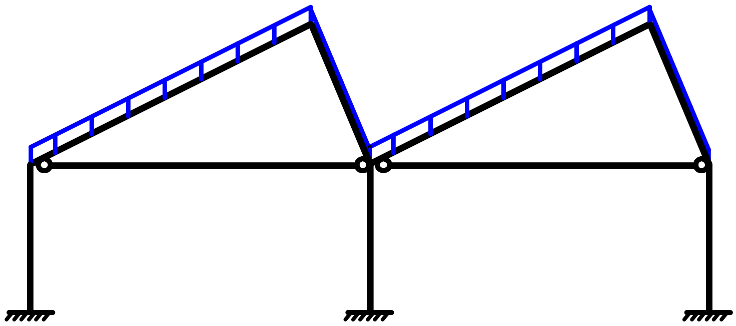
RFT. of the slab H.B. Slab.



* Analysis of the Girder.

① Exact Method.

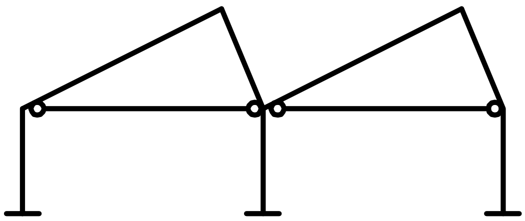
Using Computer.



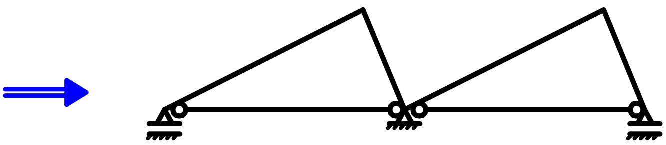
② Approximate Method.

نفرض بعض الفروض لتسهيل الحل :

١ـ نهمل إتصال ال **Girder** بالأعمده .

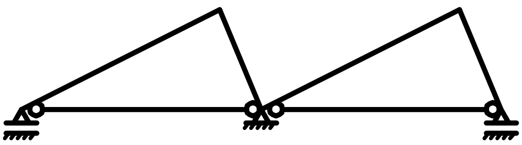


8 Times
Statically Indeterminate

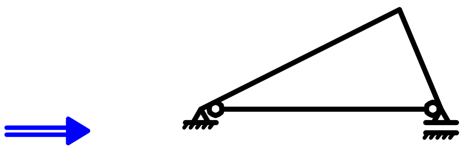


3 Times
Statically Ind.

٢ـ نهمل إتصال ال **Girder** ببعضها .

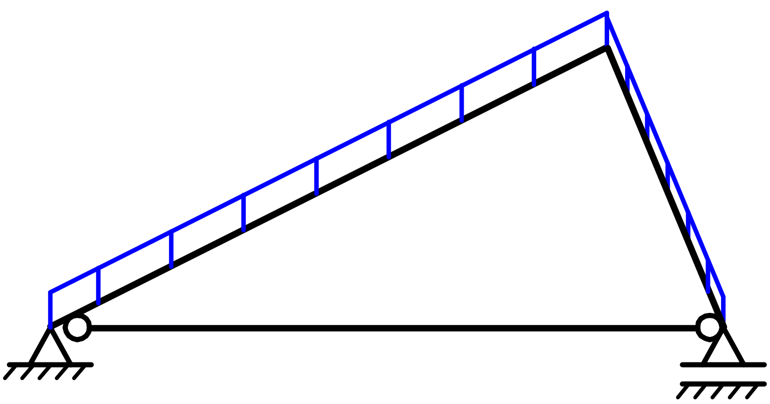


3 Times
Statically Ind.

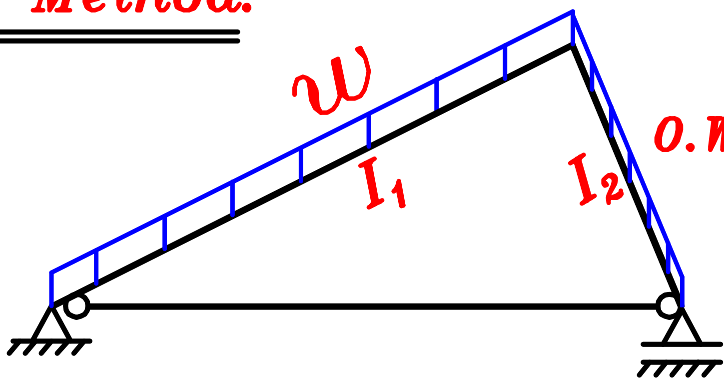


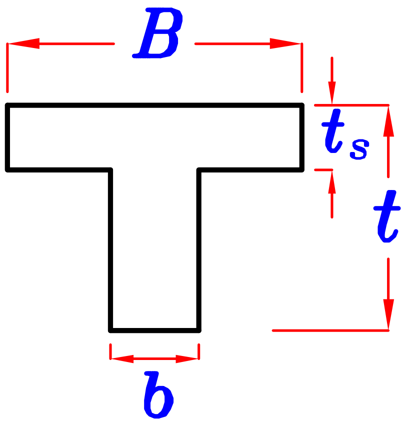
1 Times
Statically Ind.

٣ـ نحل الشكل التقريبي بـ **Using Virtual Work Method**

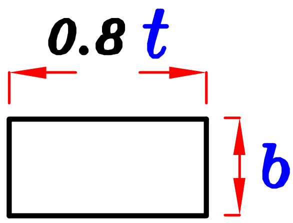


Using Virtual Work Method.

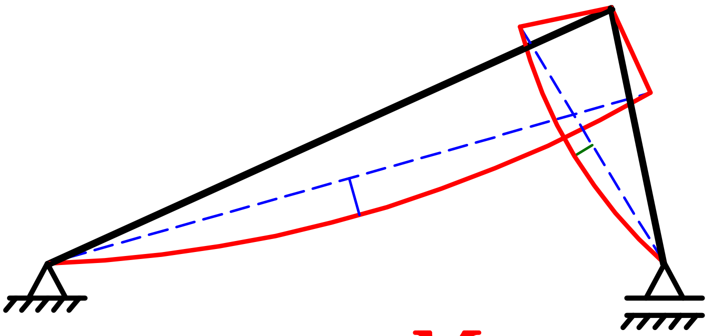




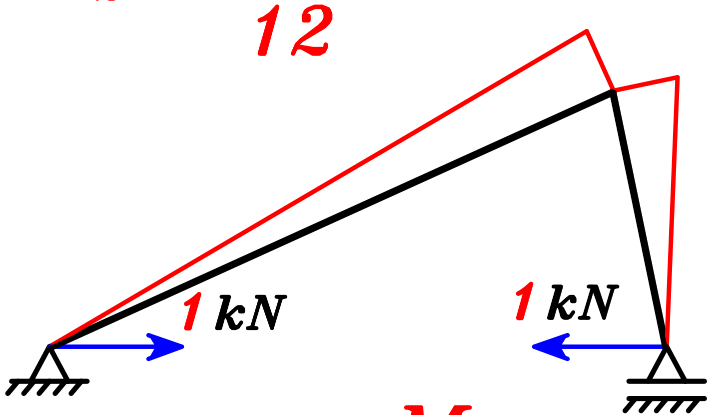
Get I_1



Get $I_2 = \dfrac{b\,(0.8\,t)^3}{12}$



Draw $M_\circ$



Draw M_1

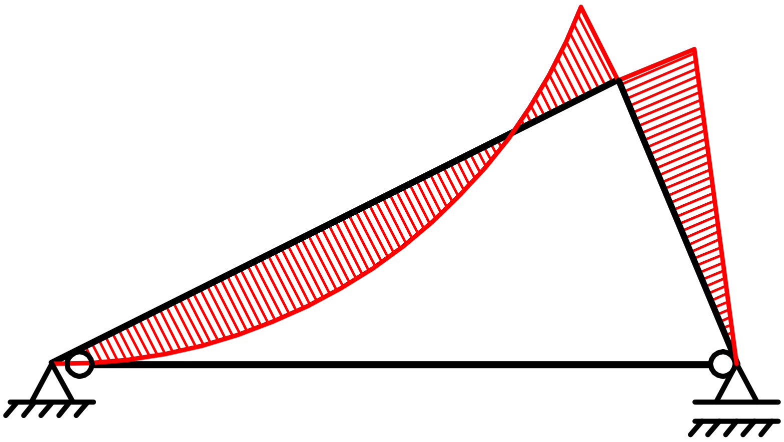
$$\delta_{1\circ} = \frac{1}{E_c\, I_1} * (M_\circ * M_1) + \frac{1}{E_c\, I_2} * (M_\circ * M_1)$$

$$\delta_{11} = \frac{1}{E_c\, I_1} * (M_1 * M_1) + \frac{1}{E_c\, I_2} * (M_1 * M_1)$$

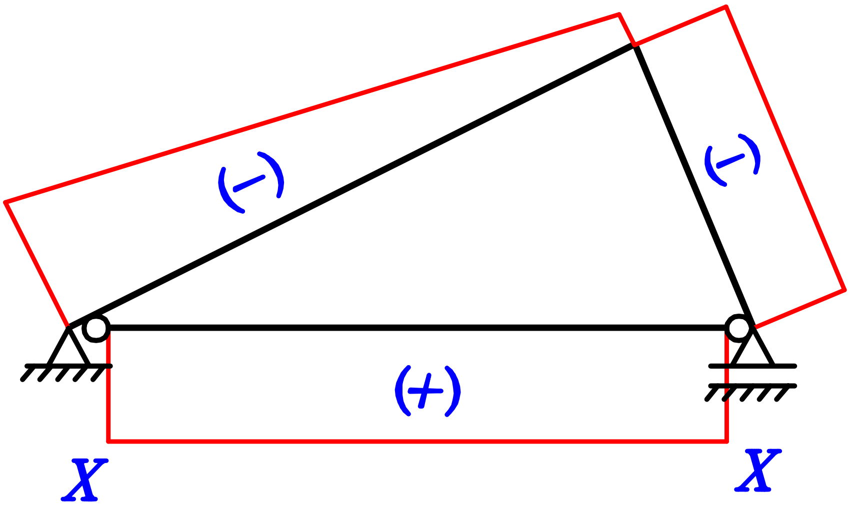
$$\boxed{\delta_{1\circ} + X\, \delta_{11} = Zero}$$ Get X

$$M_F = M_\circ + X\, M_1$$

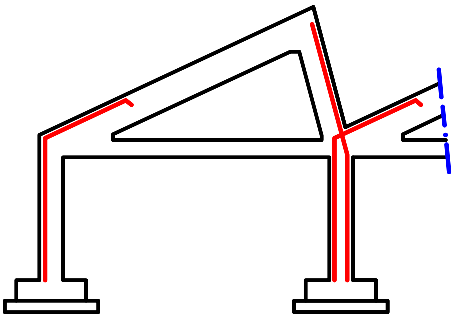
B.M.D.

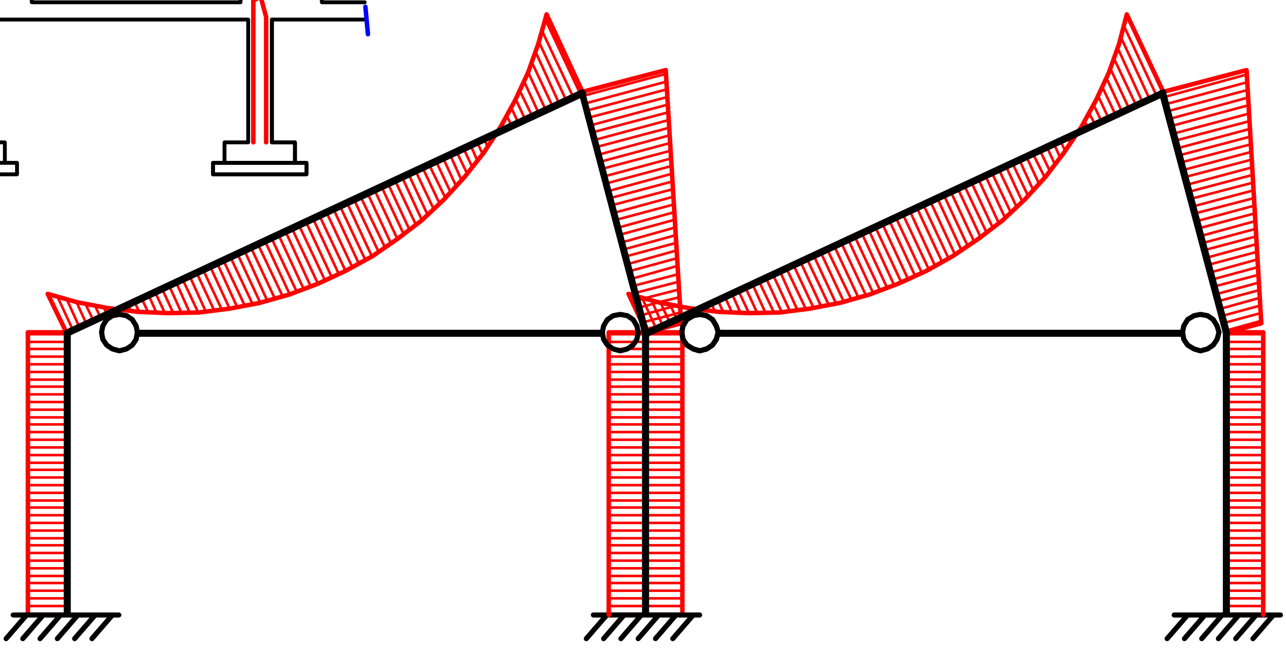


N.F.D.

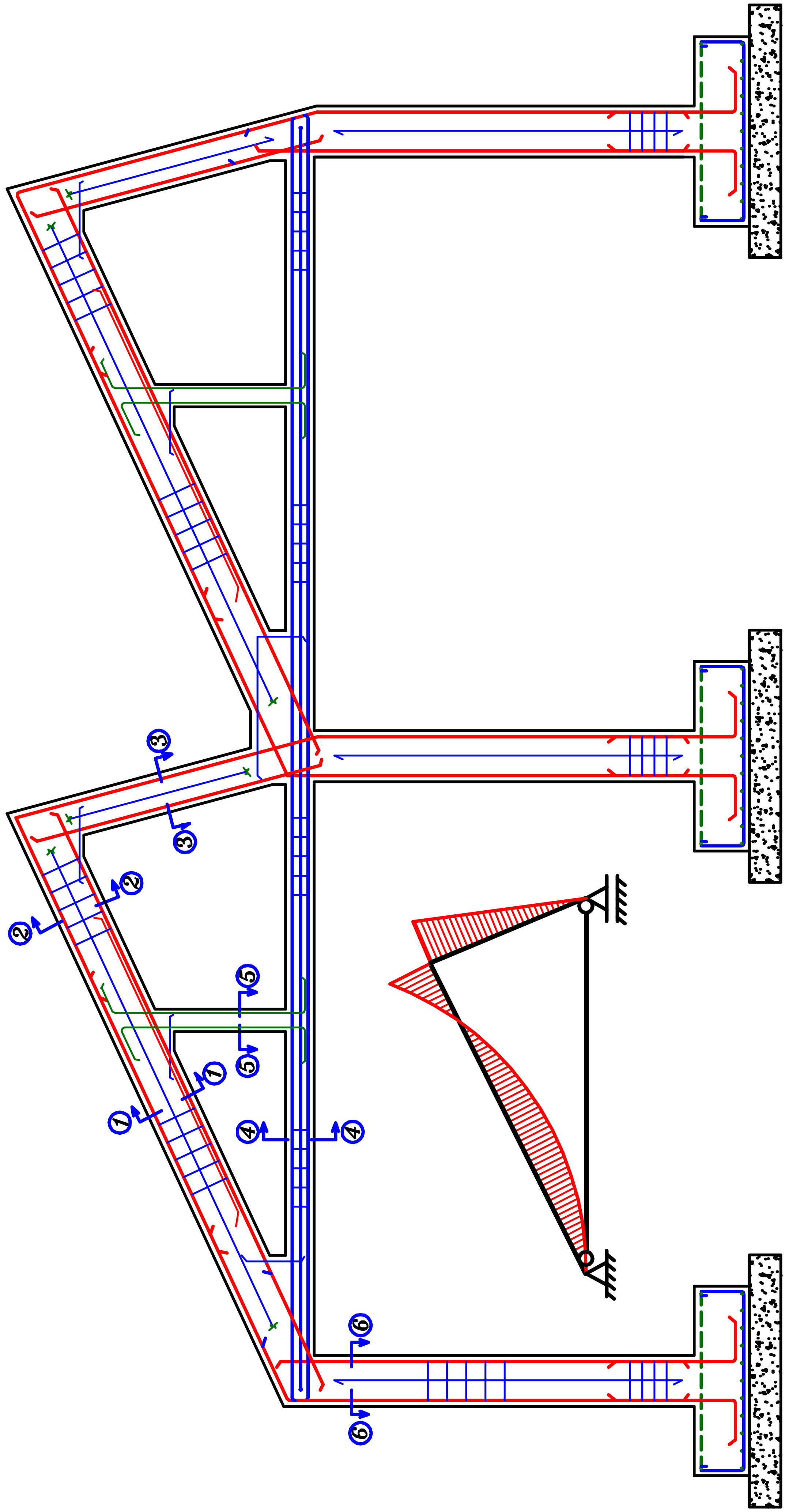


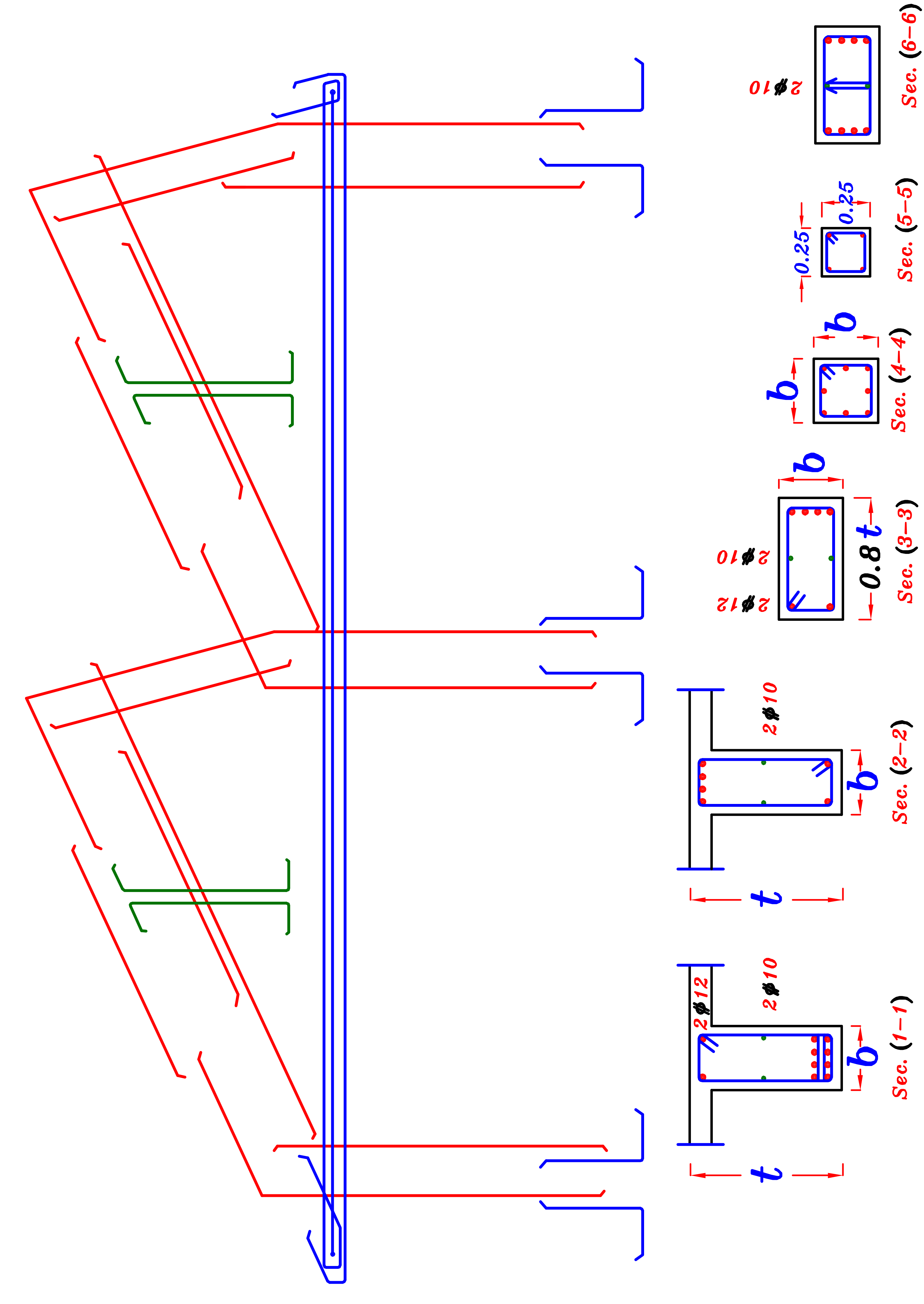
نتيجه لحدوث استطاله بسيطه فى ال **Tie**
و نتيجه لان ال **connection** بين الكمره و العمود ليست **real hinge**
فتنتقل بعض العزوم البسيطه من الكمره الى العمود
يجب عمل حسابها فى التسليح .





* RFT. of the Girder Type.




Sec. (6–6)
2∅10
Sec. (5–5)
0.25
0.25
Sec. (4–4)
b
b
Sec. (3–3)
b
0.8 t
2∅10
2∅12
Sec. (2–2)
2∅10
b
t
Sec. (1–1)
2∅12
2∅10
b
t

Example.

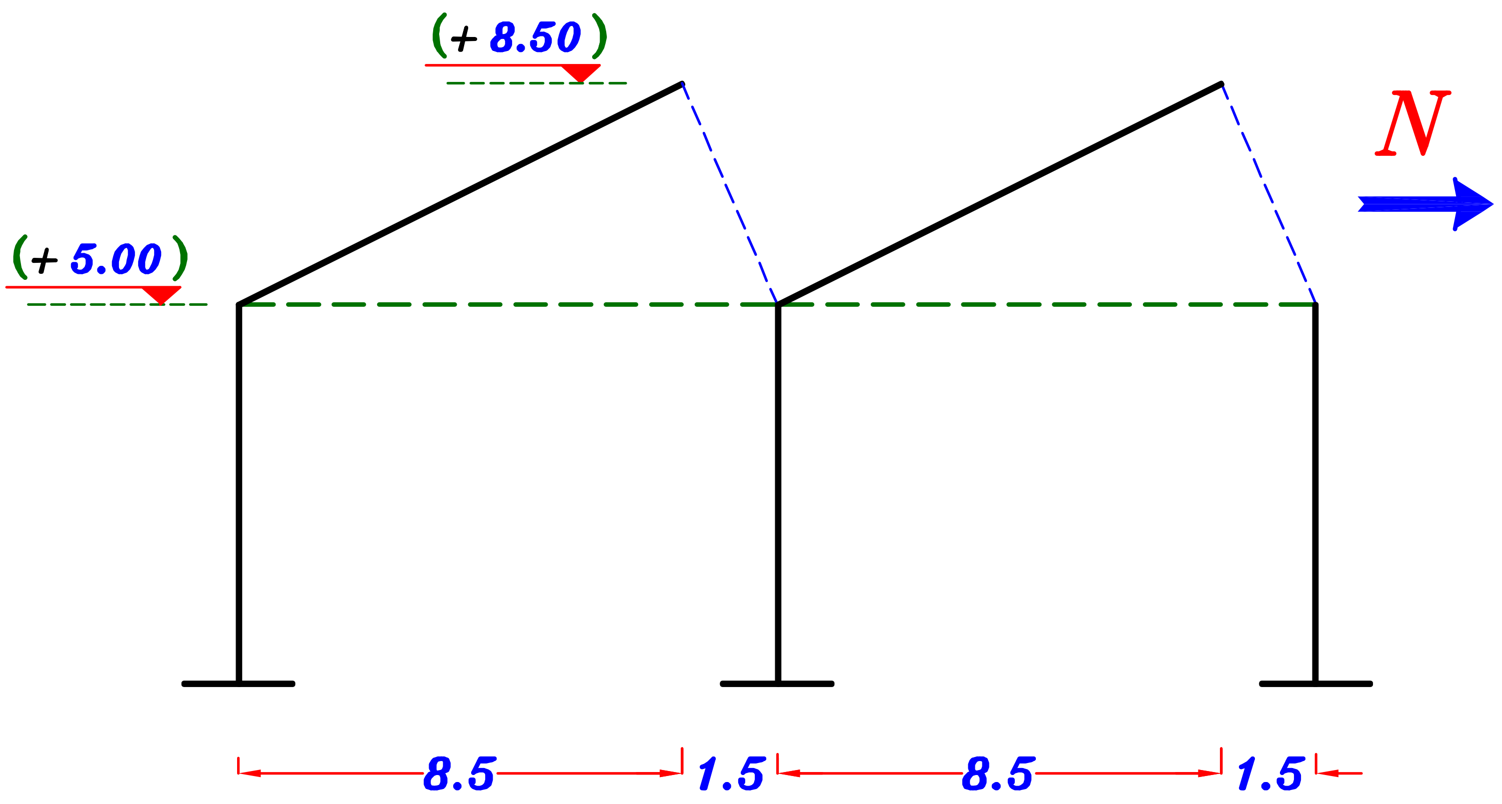


Fig shows the general layout of a north light shed covering an area of (20 * 24 m) .

Spacing between columns in the longitudinal direction is 6.0 m

Data.

* $F_{cu} = 25 \; N\backslash mm^2$
* $F_y = 360 \; N\backslash mm^2$
* $L.L. = 0.50 \; kN\backslash m^2$ (***Horizontal Projection***)
* $F.C. = 1.50 \; kN\backslash m^2$
* Foundation Level = − 2.0 m

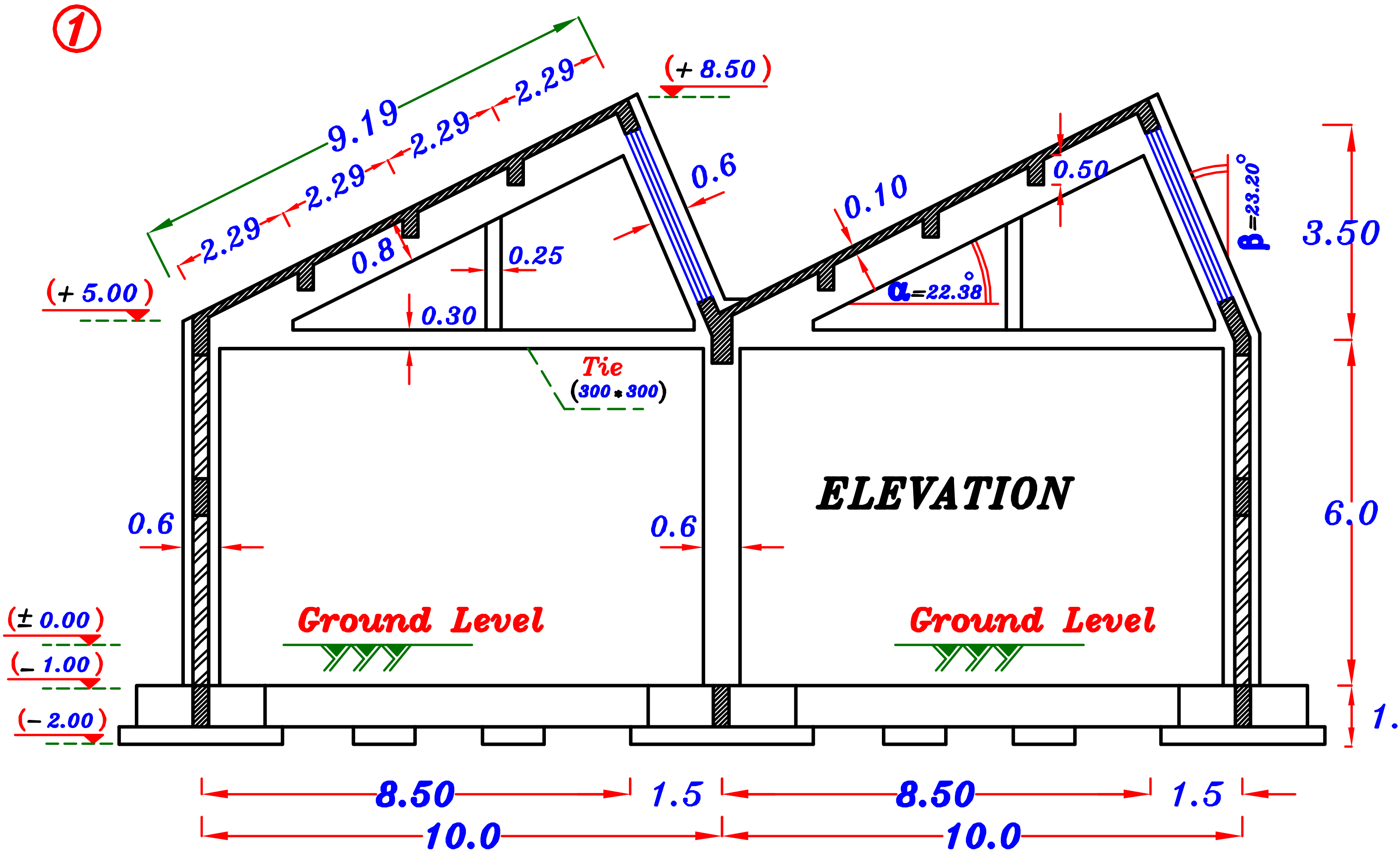
Req.

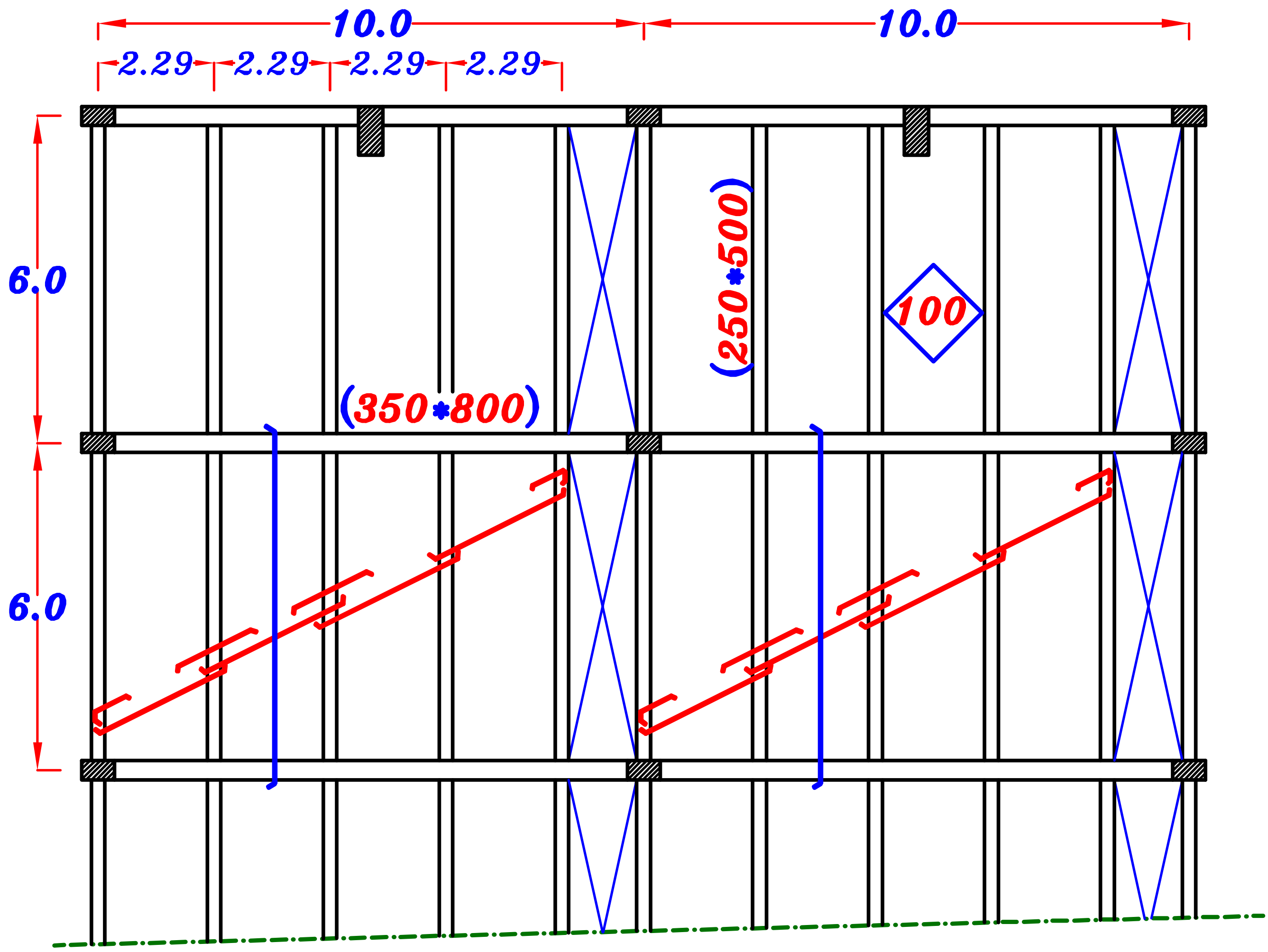
1_ Draw to scale 1:50 a sectional elevation to show Full concrete dimensions.

2_ Draw a part plan to scale 1:50 show Full concrete Dimensions. & draw a sketch of reinforcement on slabs.

3_ Complete design of an intermediate main supporting unit. and draw details of RFT. of the main unit and cross sections.

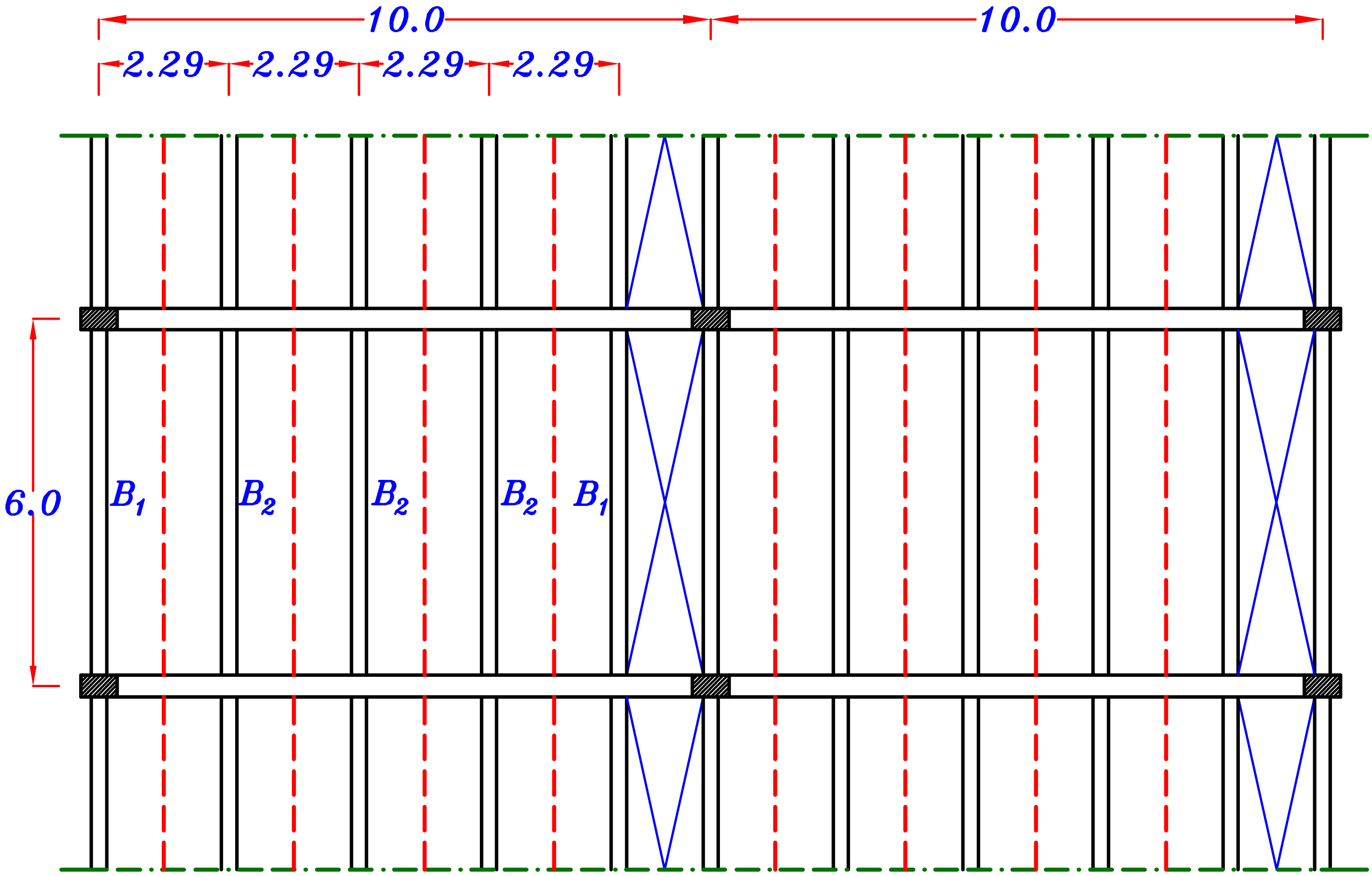
1


9.19
2.29
2.29
2.29
2.29
(+ 8.50)
(+ 5.00)
0.6
0.8
0.25
0.30
0.10
0.50
α=22.38°
β=23.20°
3.50
Tie
(300*300)
ELEVATION
6.0
0.6
0.6
(± 0.00)
(– 1.00)
(– 2.00)
Ground Level
Ground Level
1.
8.50
1.5
8.50
1.5
10.0
10.0


10.0
10.0
2.29
2.29
2.29
2.29
6.0
6.0
(250*500)
100
(350*800)

PLAN

Load Distribution.



$$t_s = \frac{2290}{30} = 76.3 \text{ mm} \quad \text{Take} \quad \boxed{t_s = 100 \text{ mm}}$$

$$w_s = 1.4\,(0.10 * 25 + 1.5) + 1.6\,(0.5)\cos 22.38^\circ = 6.34 \text{ kN}\backslash m^2$$

$\underline{\underline{B_1}}$

$$w_a = o.w. + w_s \frac{L_s}{2} = 4.20 + (6.34)\left(\frac{2.29}{2}\right) = 11.45 \text{ kN}\backslash m'$$

$$R_1 = 11.45 * 6.0 = 68.7 \text{ kN} \qquad \boxed{R_1 = 68.7 \text{ kN}}$$

$\underline{\underline{B_2}}$

$$w_a = o.w. + 2\,w_s \frac{L_s}{2} = 4.20 + 2\,(6.34)\left(\frac{2.29}{2}\right) = 18.71 \text{ kN}\backslash m'$$

$$R_2 = 18.71 * 6.0 = 112.2 \text{ kN} \qquad \boxed{R_2 = 112.2 \text{ kN}}$$

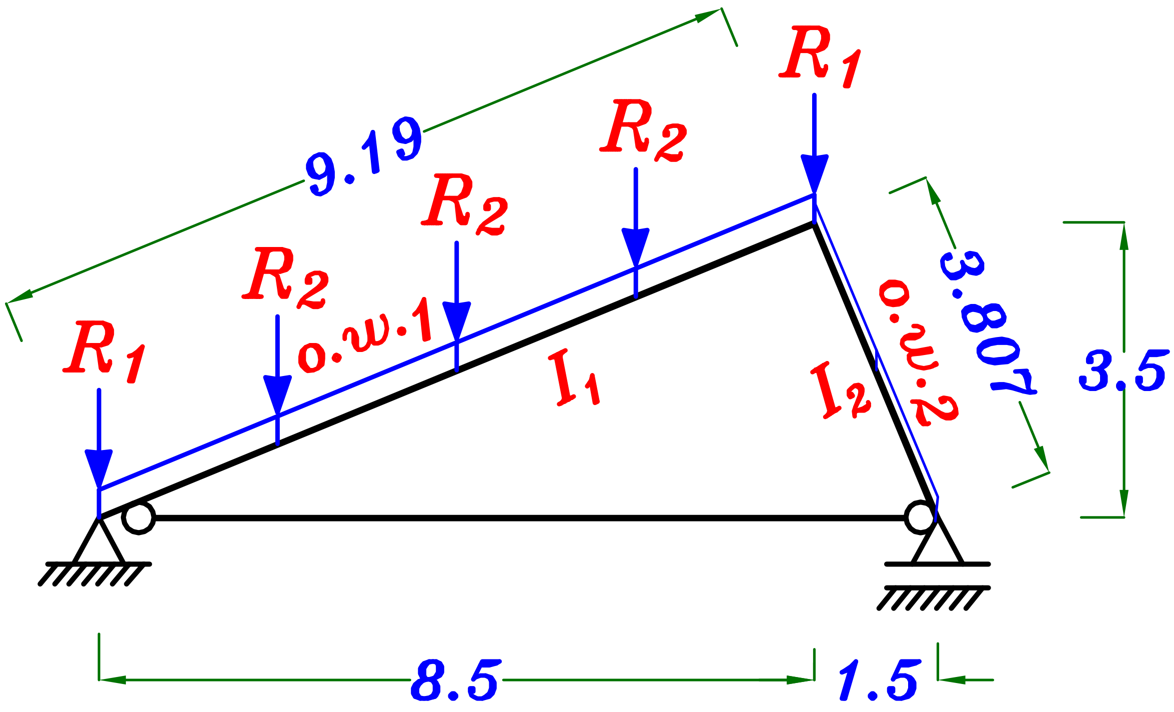
Loads on the girder.

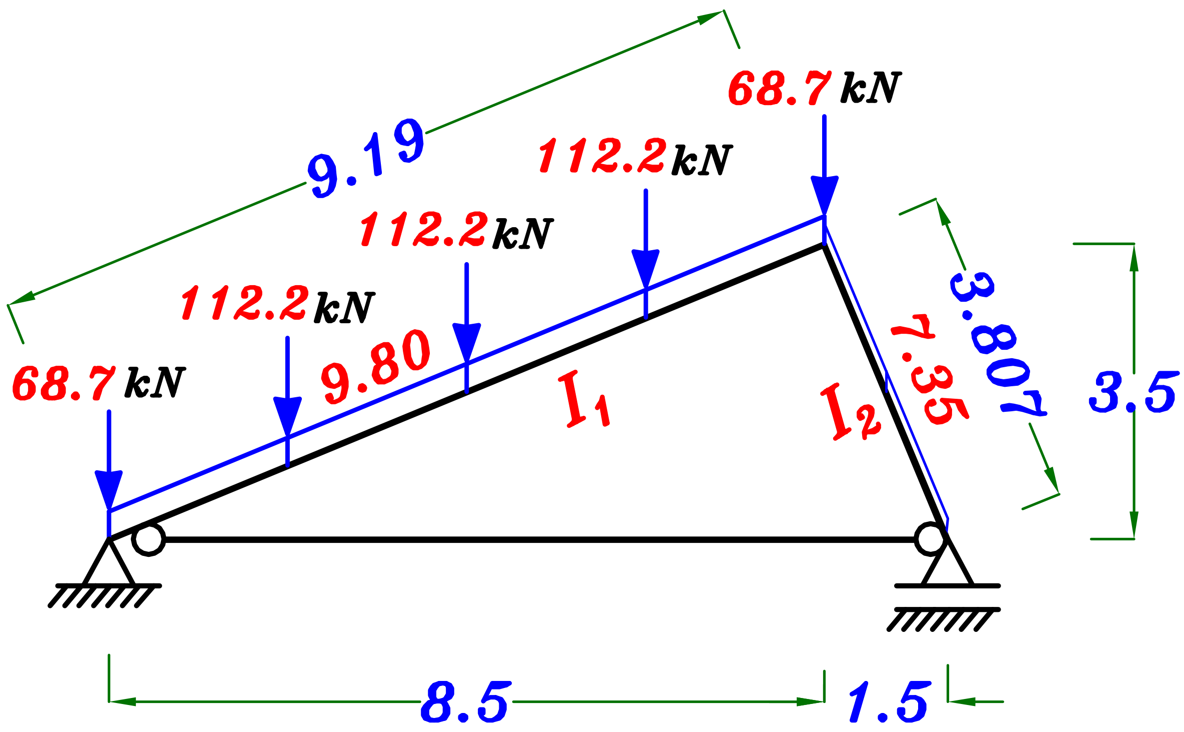
Take o.w.₁ (Girder) (350*800) $= 1.4\, b\, t\, \gamma_c$

$= 1.4\,(0.35)(0.80)\,(25) = 9.80$ kN\m

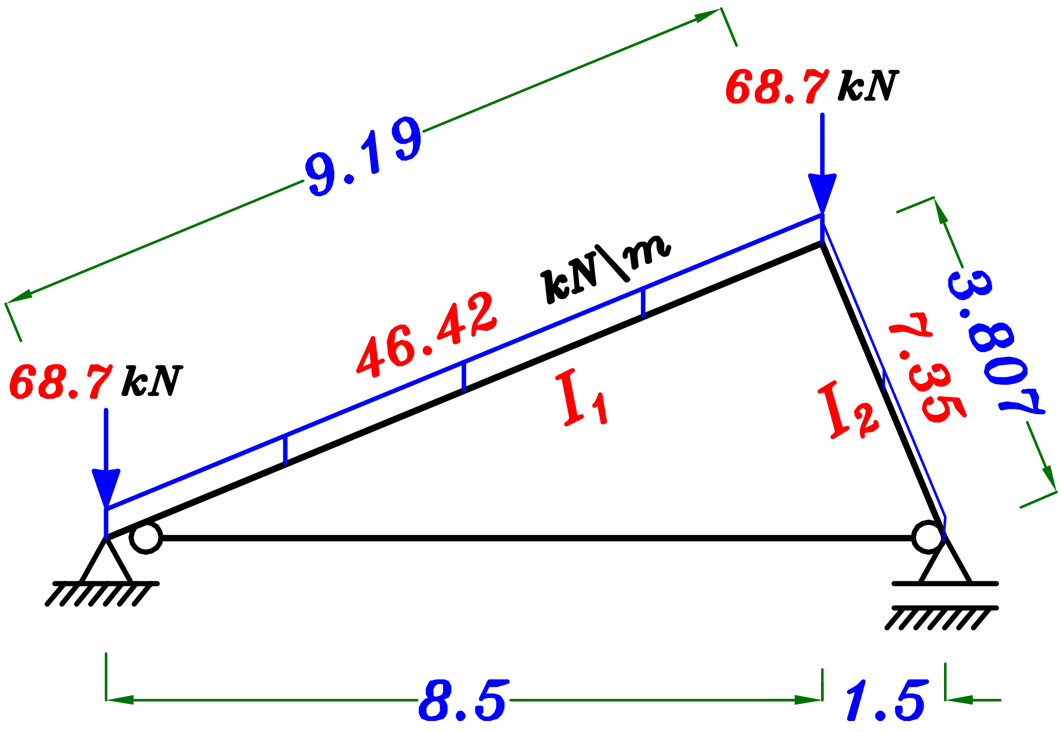
Take o.w.₂ (Girder) (350*600) $= 1.4\, b\, t\, \gamma_c$

$= 1.4\,(0.35)(0.60)\,(25) = 7.35$ kN\m

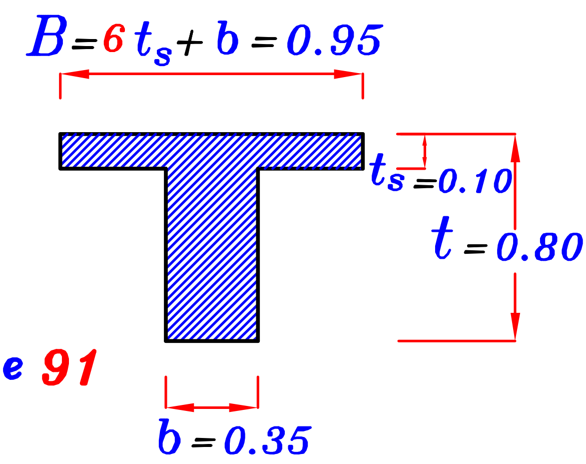




$$w = 9.80 + \frac{3\,(112.2\;)}{9.19} = 46.42 \text{ kN\m}$$



Solve the girder using Virtual Work.



$$I_1 = (\mu * 10^{-4})\; B\, t^3$$

$b = 0.35$ m , $t_s = 0.10$ m

$B = 0.95$ m , $t = 0.80$ m

$$\frac{t_s}{t} = \frac{0.10}{0.80} = 0.125$$

$$\frac{b}{B} = \frac{0.35}{0.95} = 0.368$$

From Tables page 91

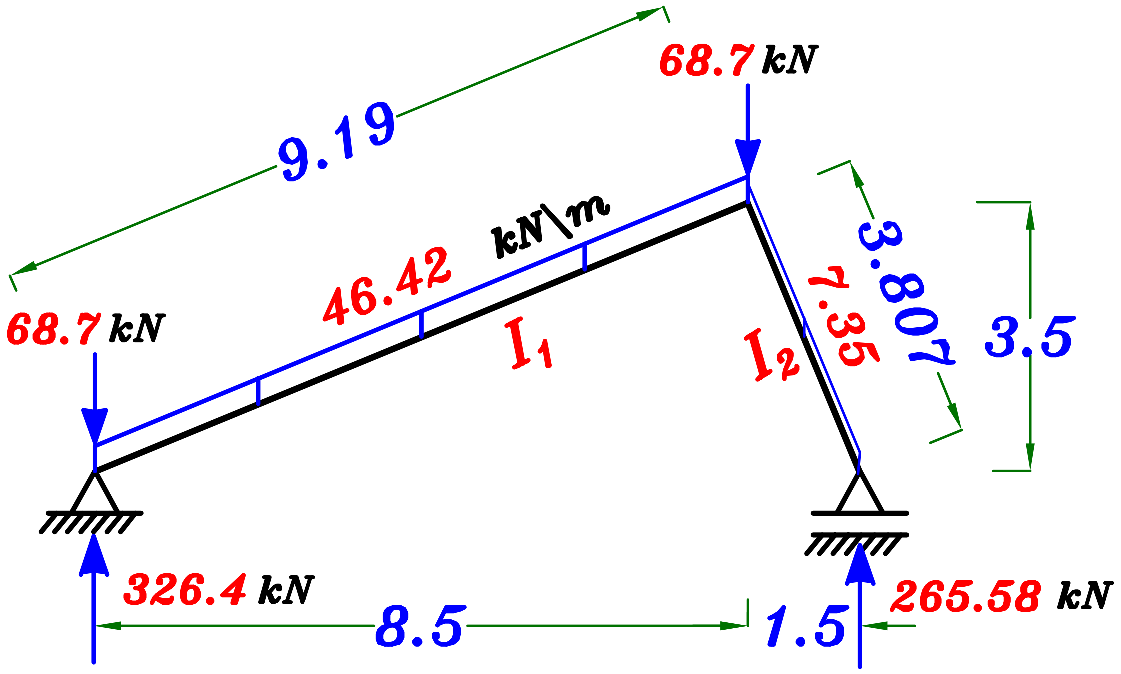
$\mu = 415$

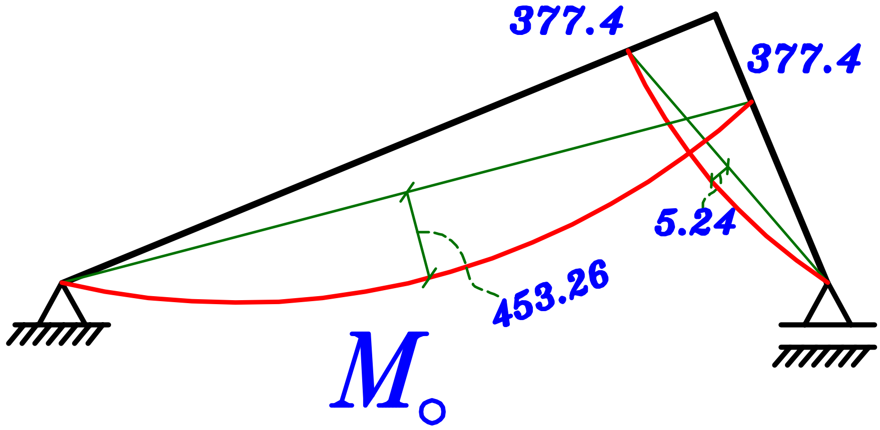
$$I_1 = (\mu * 10^{-4})\; B\, t^3 = (415 * 10^{-4} * 0.95 * 0.80^3) = 0.020 \;\; m^4$$

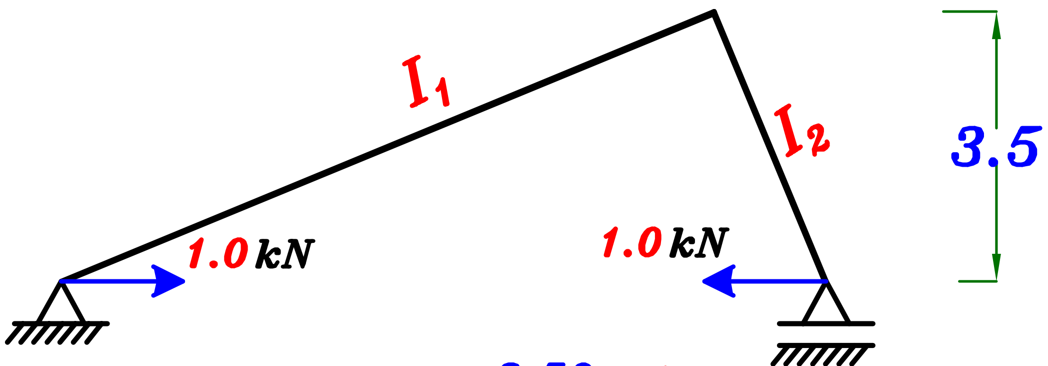
$$I_2 = \frac{b\;(0.8\,t)^3}{12} = \frac{0.35\;(0.60)^3}{12} = 0.0063\; m^4$$

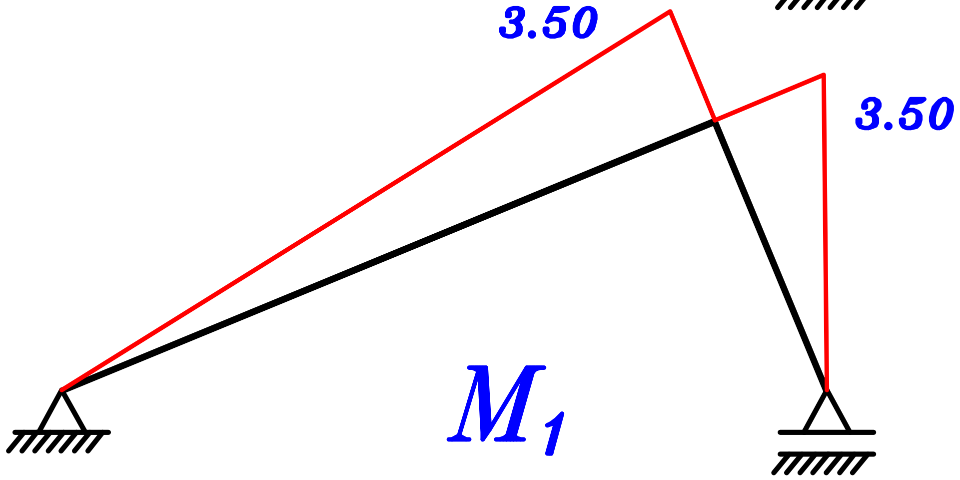
$$\boxed{I_1 = 3.175\; I_2}$$

Solve using Virtual Work Method









Neglect the Extension of the Tie. $\Delta_{Tie} = Zero$

$$\delta_{10} = \frac{1}{E_c I_1} * (M_o * M_1) + \frac{1}{E_c I_2} * (M_o * M_1)$$

$$\delta_{10} = \frac{-1}{E_c (3.175) I_2}\left(\tfrac{1}{2}(377.4)(9.19)(\tfrac{2}{3}*3.5) + \tfrac{2}{3}(453.26)(9.19)(\tfrac{1}{2}*3.5)\right)$$

$$\frac{-1}{E_c \; I_2}\left(\tfrac{1}{2}(377.4)(3.807)(\tfrac{2}{3}*3.5) + \tfrac{2}{3}(5.24)(3.807)(\tfrac{1}{2}*3.5)\right)$$

$$= \frac{-4504.55}{E_c \; I_2}$$

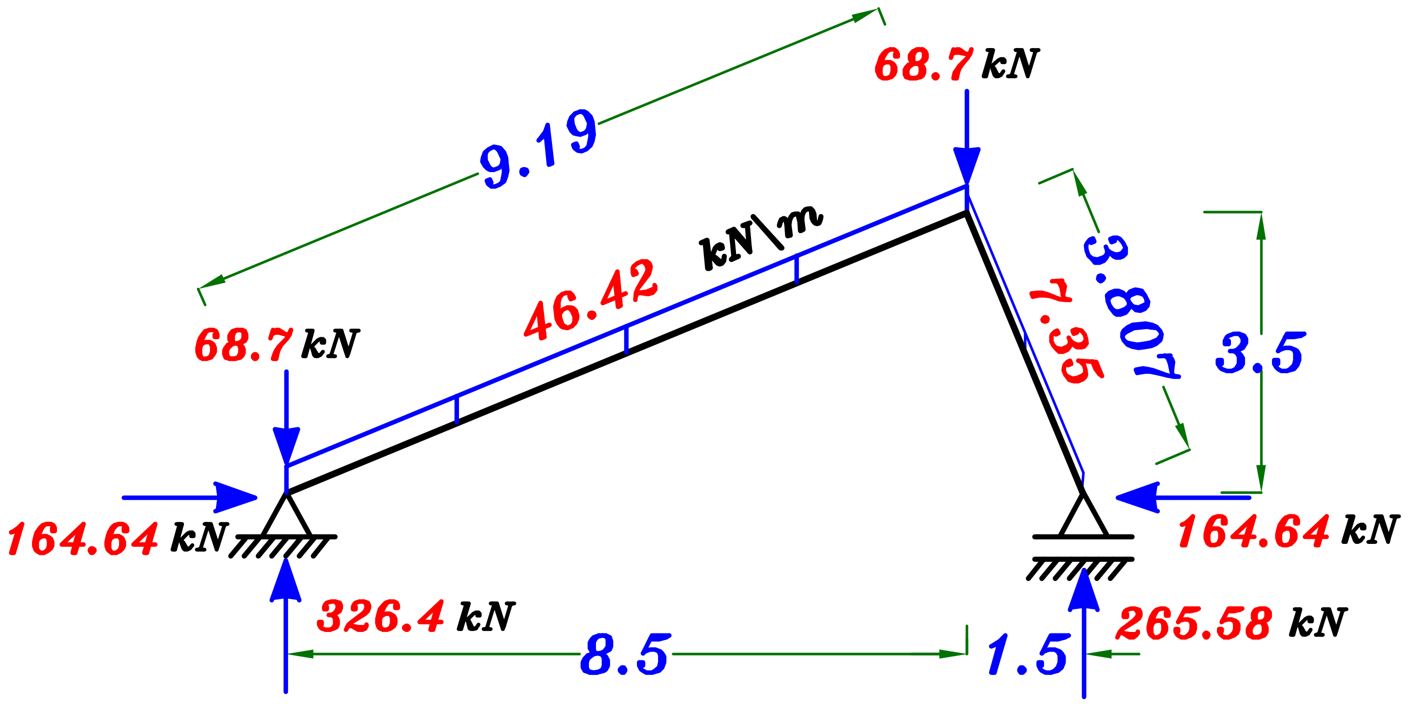
$$\delta_{11} = \frac{1}{E_c I_1} * (M_1 * M_1) + \frac{1}{E_c I_2} * (M_1 * M_1)$$

$$\delta_{11} = \frac{1}{E_c (3.175) I_2}\left(\tfrac{1}{2}(3.5)(9.19)(\tfrac{2}{3}*3.5)\right)$$

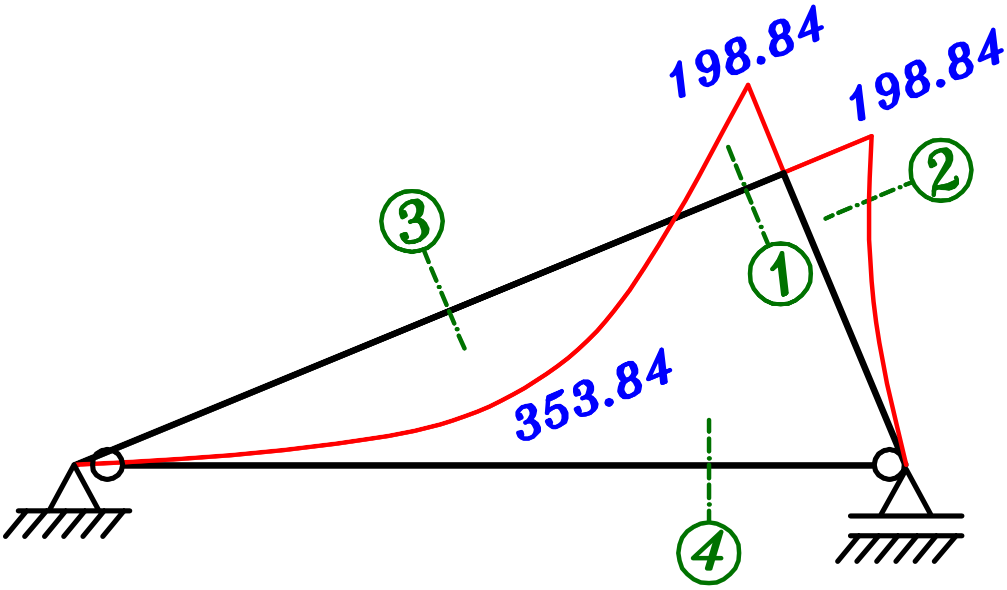
$$+ \frac{1}{E_c \; I_2}\left(\tfrac{1}{2}(3.5)(3.807)(\tfrac{2}{3}*3.5)\right) = \frac{27.36}{E_c \; I_2}$$

$$\because \; \delta_{10} + X \; \delta_{11} = Zero$$

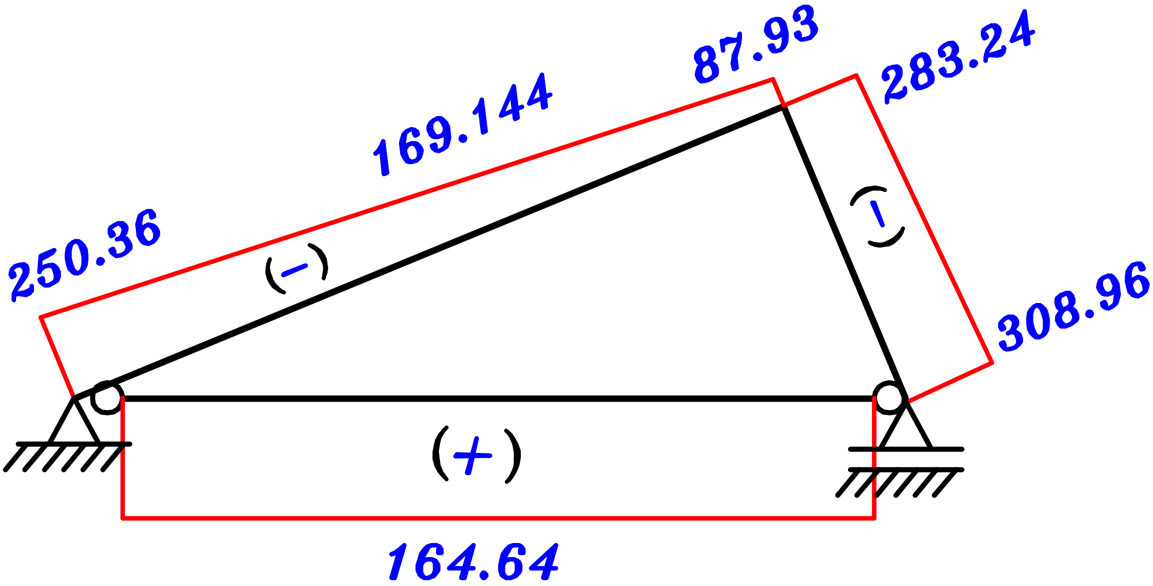
$$\therefore \; \frac{-4504.55}{E_c \; I_2} + X * \frac{27.36}{E_c \; I_2} \longrightarrow \boxed{X = 164.64 \; kN}$$



B.M.D.



N.F.D.



Sec. ① R−Sec.

$M = 198.84\ kN.m\ ,\ P = 87.93\ kN\ ,\ b = 0.35\ m\ ,\ t = 0.8\ m$

Check $\dfrac{P}{F_{cu}\, b\, t} = \dfrac{87.93 * 10^3}{25 * 350 * 800} = 0.0125 < 0.04$ (neglect P)

$\therefore 750 = C_1 \sqrt{\dfrac{198.84 * 10^6}{25 * 350}} \longrightarrow C_1 = 4.975 \longrightarrow J = 0.826$

$$\therefore A_s = \frac{M_{U.L.}}{J\, F_y\, d} = \frac{198.84 * 10^6}{0.826 * 360 * 750} = 891.58\ mm^2$$

Check $A_{s\,min.}$ $\quad A_{s_{req.}} = 891.58\ mm^2$

$$\mu_{min.}\, b\, d = \left(0.225 * \frac{\sqrt{F_{cu}}}{F_y}\right) b\, d = \left(0.225 * \frac{\sqrt{25}}{360}\right) 350 * 750 = 820.3\ mm^2$$

$$\therefore A_{s_{req.}} > \mu_{min.}\, b\, d \quad \therefore \text{Take } A_s = A_{s_{req.}} = 891.58\ mm^2 \quad 5\phi16$$

$$\therefore n = \frac{b - 25}{\phi + 25} = \frac{350 - 25}{16 + 25} = 7.92 = 7.0\ \text{bars}$$

Sec. ② R−Sec.

$M = 198.84$ kN.m , $P = 283.24$ kN, $b = 0.35$ m , $t = 0.60$ m

$$\text{Check} \quad \frac{P}{F_{cu}\, b t} = \frac{283.24 * 10^3}{25 * 350 * 600} = 0.054 > 0.04 \quad (\text{Don't neglect } P)$$

$$e = \frac{M}{P} = \frac{198.84}{283.24} = 0.70\, m \qquad \therefore \frac{e}{t} = \frac{0.70}{0.60} = 1.167 > 0.5 \xrightarrow{use} e_s$$

$$e_s = e + \frac{t}{2} - c = 0.70 + \frac{0.6}{2} - 0.05 = 0.95\ m$$

$$M_S = P * e_s = 283.24 * 0.95 = 269.08\ \text{kN.m}$$

$$\therefore 550 = C_1 \sqrt{\frac{269.08 * 10^6}{25 * 350}} \longrightarrow C_1 = 3.14 \longrightarrow J = 0.756$$

$$\therefore A_S = \frac{M_S}{J\, F_y\, d} - \frac{P_{U.L.}}{(F_y \backslash \gamma_s)} = \frac{269.08 * 10^6}{0.756 * 360 * 550} - \frac{283.24 * 10^3}{(360 \backslash 1.15)}$$

$$= 892.8\ mm^2$$

Check $A_{s\,min.}$ $\quad A_{s_{req.}} = 892.8\ mm^2$

$$\mu_{min.}\, b\, d = \left(0.225 * \frac{\sqrt{F_{cu}}}{F_y}\right) b\, d = \left(0.225 * \frac{\sqrt{25}}{360}\right) 350 * 550 = 601.5\ mm^2$$

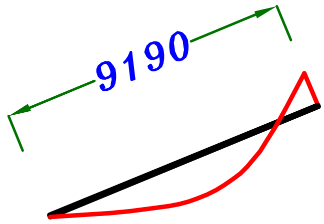
$$\therefore A_{s_{req.}} > \mu_{min.}\, b\, d \quad \therefore \text{Take } A_s = A_{s_{req.}} = 892.8\ mm^2 \quad 5\phi16$$

Sec. ③ T-Sec.

$M = 353.84$ kN.m , $P = 169.144$ kN , $t = 0.8$ m

Check $\dfrac{P}{F_{cu}\, b\, t} = \dfrac{169.144 * 10^3}{25 * 350 * 800} = 0.0241 < 0.04$ (neglect P)

$$B = \begin{cases} C.L.-C.L. = 6.0\ m = 6000\ mm \\ 16\ t_s + b = 16 * 100 + 350 = 1950\ mm \\ K \dfrac{L}{5} + b = 0.8 * \dfrac{9190}{5} + 350 = 1820.4\ mm \end{cases}$$



$\boxed{B = 1820.4\ mm}$

$$\therefore 750 = C_1 \sqrt{\frac{353.84 * 10^6}{25 * 1820.4}} \longrightarrow C_1 = 8.50 \longrightarrow J = 0.826$$

$$\therefore A_s = \frac{M_{U.L.}}{J\, F_y\, d} = \frac{353.84 * 10^6}{0.826 * 360 * 750} = 1586.6\ mm^2$$

Check $A_{s\,min.}$ $\qquad A_{s_{req.}} = 1586.6\ mm^2$

$$\mu_{min.}\, b\, d = \left(0.225 * \frac{\sqrt{F_{cu}}}{F_y}\right) b\, d = \left(0.225 * \frac{\sqrt{25}}{360}\right) 350 * 750 = 820.3\ mm^2$$

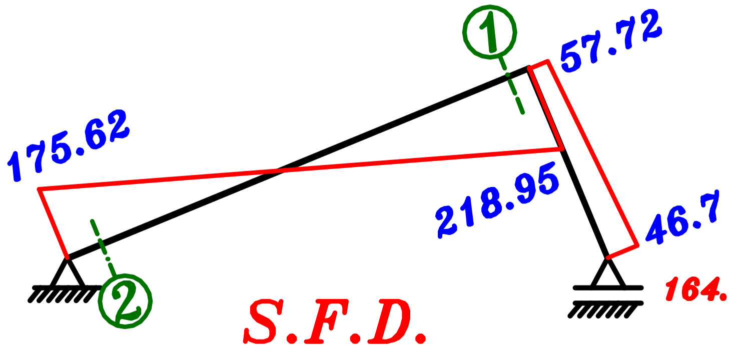
$\therefore A_{s_{req.}} > \mu_{min.}\, b\ d$ $\quad \therefore$ Take $A_s = A_{s_{req.}} = 1586.6\ mm^2$ $\quad$ 8 ϕ 16

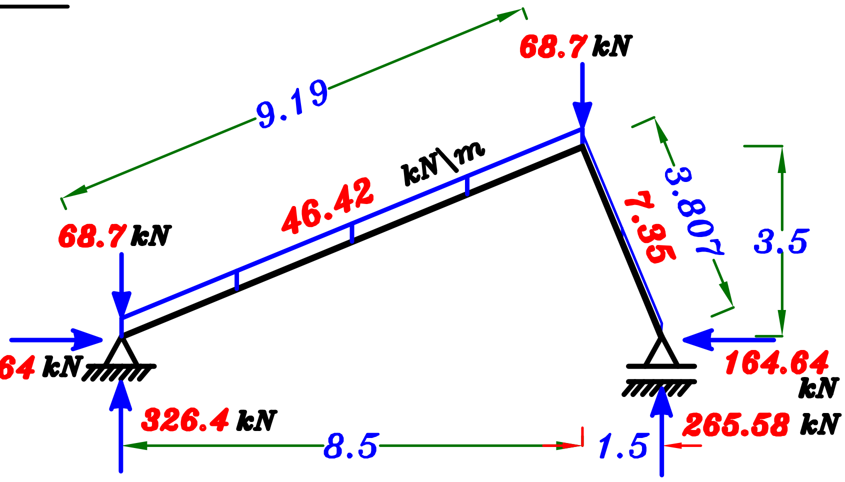
Sec. ④ (300 * 300) $T = 164.64$ kN

$$A_s = \frac{T}{F_y \backslash \gamma_s} = \frac{164.64 * 10^3}{360 \backslash 1.15} = 525.93\ mm^2$$

4 ϕ 16

Check Shear.





$$q_{cu} = (0.24)\sqrt{\frac{25}{1.50}} = 0.98 \quad N\backslash mm^2$$

$$q_{u_{max}} = (0.70)\sqrt{\frac{25}{1.50}} = 2.85 \quad N\backslash mm^2$$

Sec. ①

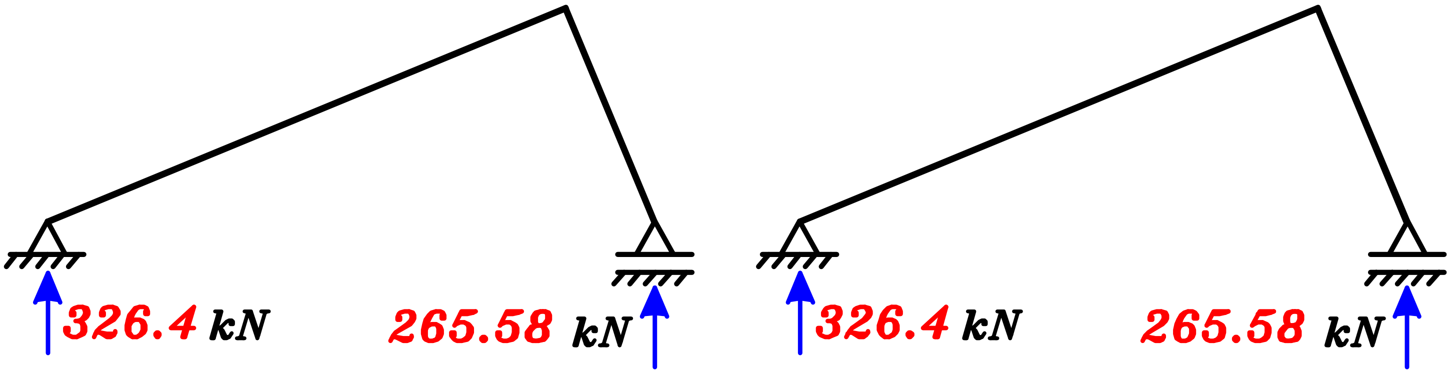
$$q_u = \frac{Q_{max}}{b\,d} = \frac{218.95 * 10^3}{350 * 750} = 0.834 \; N\backslash mm^2 \qquad \because \; q_u < q_{cu}$$

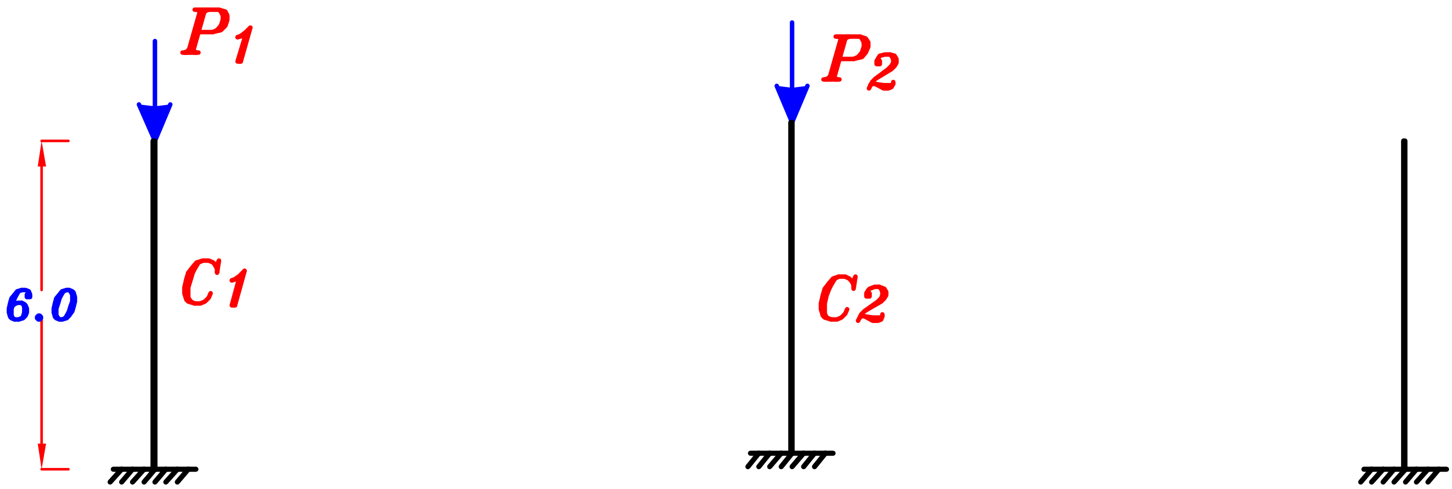
$\therefore$ Use min. Shear RFT. $5\phi 8\backslash m'$

Sec. ②

$$q_u = \frac{Q_{max}}{b\,d} = \frac{175.62 * 10^3}{350 * 750} = 0.67 \; N\backslash mm^2 \qquad \because \; q_u < q_{cu}$$

$\therefore$ Use min. Shear RFT. $5\phi 8\backslash m'$



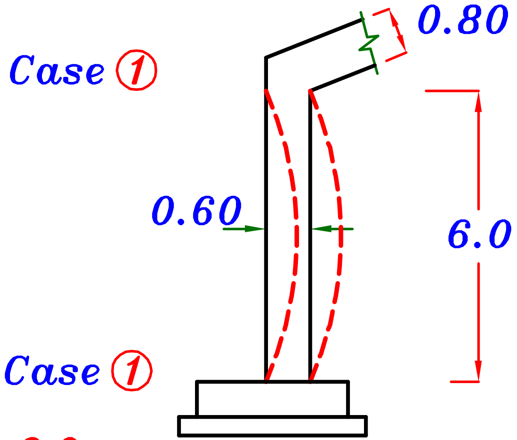


$$P_1 = 326.4 \ kN$$

$$P_2 = 265.58 + 326.4 = 592.0 \ kN$$

C1 $P_1 = 326.4$ kN Check Buckling

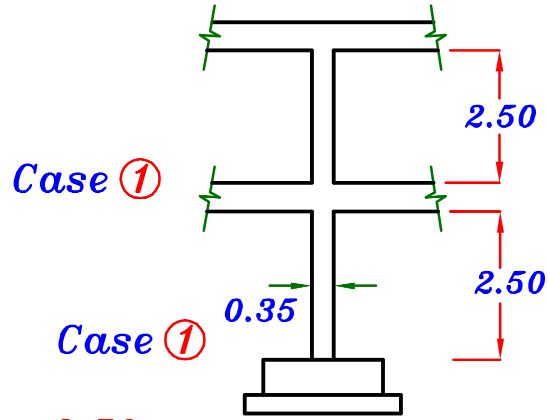
① Inplane.



$H_o = 6.0\ m$

$$\lambda_b = \frac{K * H_o}{t} = \frac{1.2 * 6.0}{0.60} = 12.0 > 10$$

② Out of plane.



$H_o = 2.50\ m$

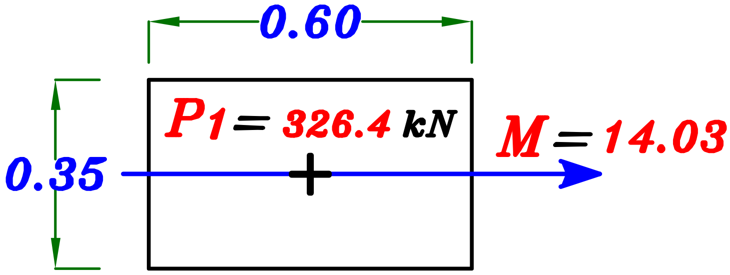
$$\lambda_b = \frac{K * H_o}{b} = \frac{1.2 * 2.50}{0.35} = 8.50$$

Long column at Inplane.

$$\delta = \frac{(\lambda_b)^2 * t}{2000} = \frac{12.0^2 * 0.60}{2000} = 0.043\ m$$

$$M_{add.} = P * \delta = 326.4 * 0.043 = 14.03\ kN.m$$

Design of section.



$$e = \frac{M}{P} = \frac{14.03}{326.4} = 0.043\ m$$

$$\therefore \frac{e}{t} = \frac{0.043}{0.6} = 0.07 < 0.5 \xrightarrow{use} \text{I.D.}$$

$$\zeta = \frac{0.60 - 0.1}{0.60} = 0.83 = 0.80 \xrightarrow{use} \text{ECCS Page 4-24}$$

$$\frac{P_U}{F_{cu}\, b\, t} = \frac{326.4 * 10^3}{25 * 350 * 600} = 0.062$$

$$\frac{M_U}{F_{cu}\, b\, t^2} = \frac{14.03 * 10^6}{25 * 350 * 600^2} = 0.004$$

$$\left.\right\} \rho < 1.0 \xrightarrow{Take} \rho = 1.0$$

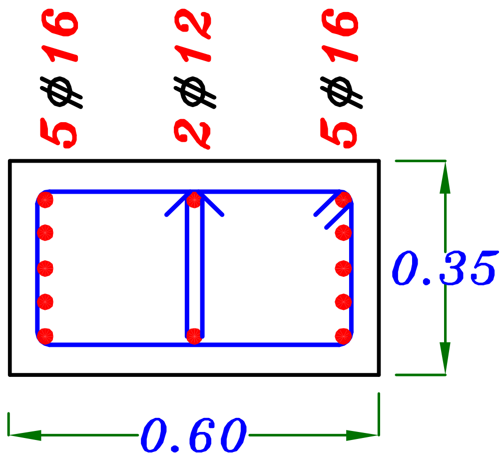
$$As = As` = \mu * b * t = \rho * F_{cu} * 10^{-4} * b * t = 1.0 * 25 * 10^{-4} * 350 * 600 = 525 \quad mm^2$$

$$As_{total} = As + As` = 1050 \ mm^2$$

$$As_{min} = \frac{0.25 + 0.052 \ \lambda_{max}}{100} * b * t$$

$$= \frac{0.25 + 0.052 \ (12.0)}{100} * 350 * 600 = 1835.4 \ mm^2 > As_{total}$$

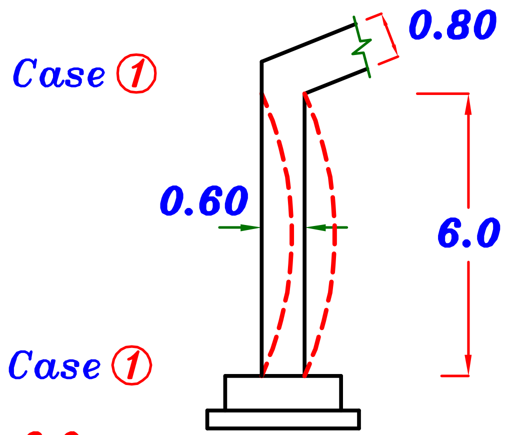
$$As = As` = \frac{1835.4}{2} = 917.7 \ mm^2 \quad 5 \phi 16$$



C2 $P_2 = 592.0 \ kN$

Check Buckling

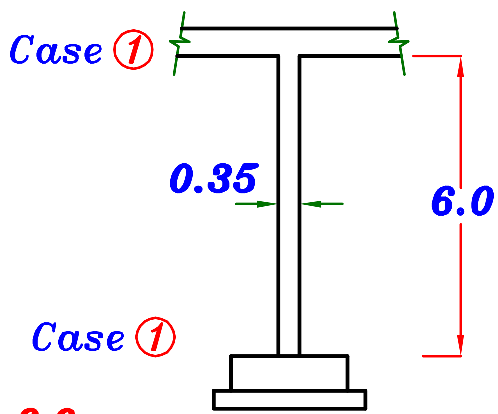
① In plane.



$H_o = 6.0 \ m$

$$\lambda_b = \frac{K * H_o}{t} = \frac{1.2 * 6.0}{0.60} = 12.0 > 10$$

② Out of plane.



$H_o = 6.0 \ m$

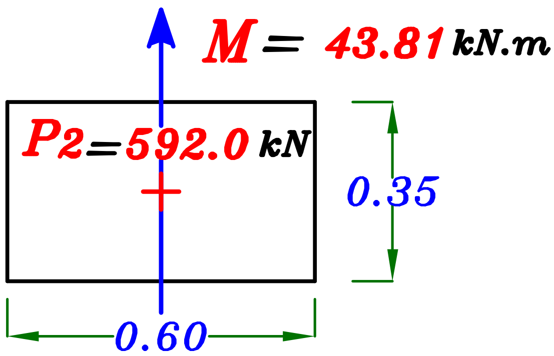
$$\lambda_b = \frac{K * H_o}{b} = \frac{1.2 * 6.0}{0.35} = 20.57$$

Long column at Out of plane direction.

$$\delta = \frac{(\lambda_b)^2 * b}{2000} = \frac{20.57^2 * 0.35}{2000} = 0.074 \ m$$

$$M_{add.} = P * \delta = 592.0 * 0.074 = 43.81 \ kN.m$$

Design of section.



$$e = \frac{M}{P} = \frac{43.81}{592.0} = 0.074 \ m$$

$$\therefore \frac{e}{t} = \frac{0.074}{0.35} = 0.211 < 0.5 \xrightarrow{use} I.D.$$

$$\zeta = \frac{0.35-0.1}{0.35} = 0.71 \xrightarrow{use} \text{ECCS Page } 4\text{–}25$$

$$\left.\begin{aligned} \frac{P_U}{F_{cu}\, b\, t} &= \frac{592.0 * 10^3}{25 * 600 * 350} = 0.112 \\ \frac{M_U}{F_{cu}\, b\, t^2} &= \frac{43.81 * 10^6}{25 * 600 * 350^2} = 0.023 \end{aligned}\right\} \rho < 1.0 \xrightarrow{Take} \rho = 1.0$$

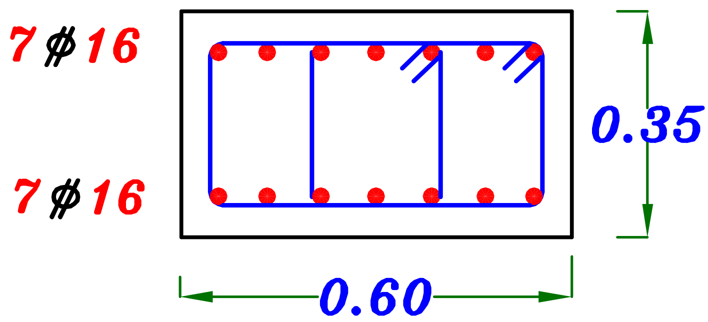
$$As = As` = \mu * b * t = \rho * F_{cu} * 10^{-4} * b * t = 1.0 * 25 * 10^{-4} * 600 * 350 = 525 \ mm^2$$

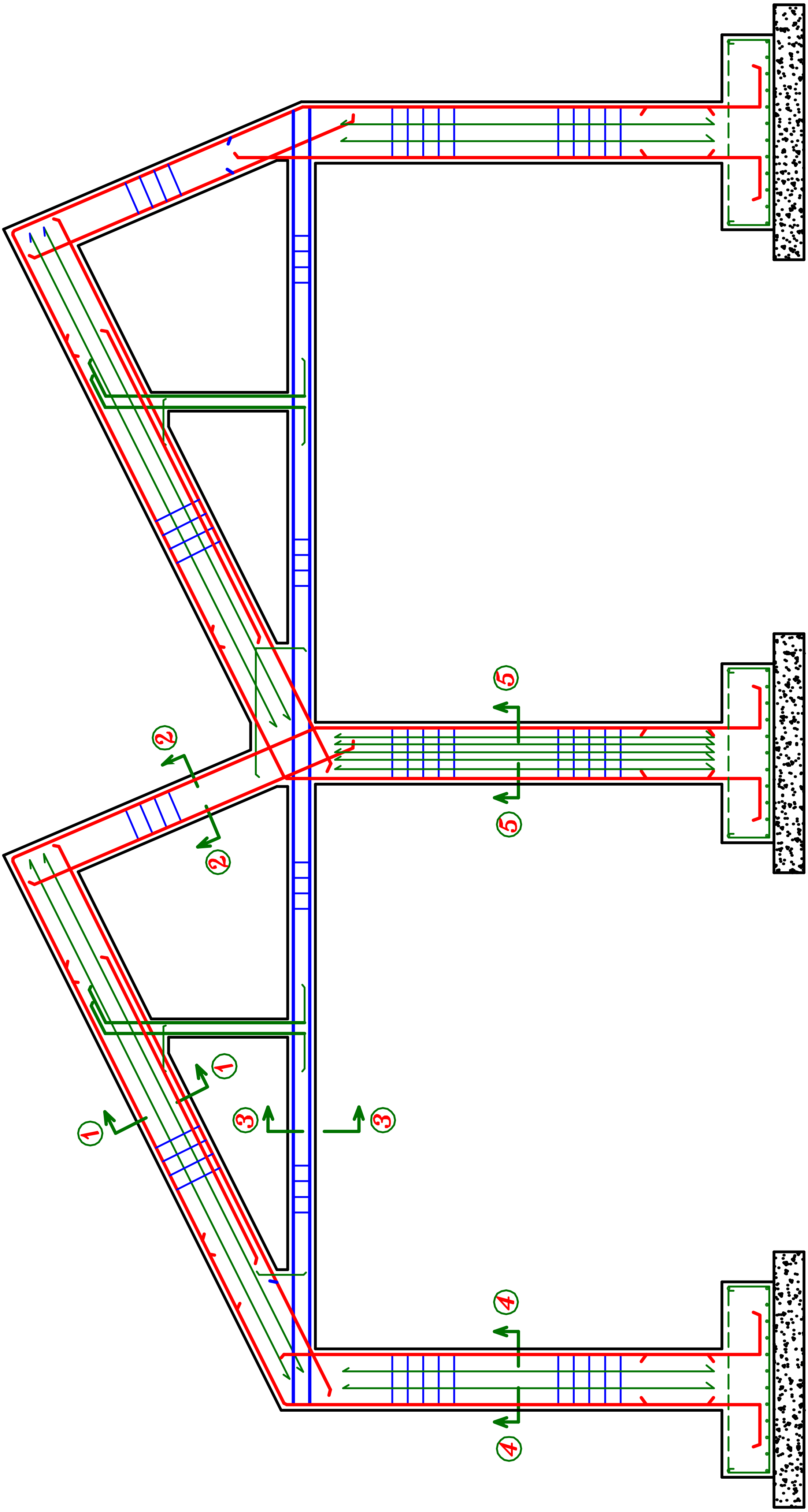
$$As_{total} = As + As` = 1050 \ mm^2$$

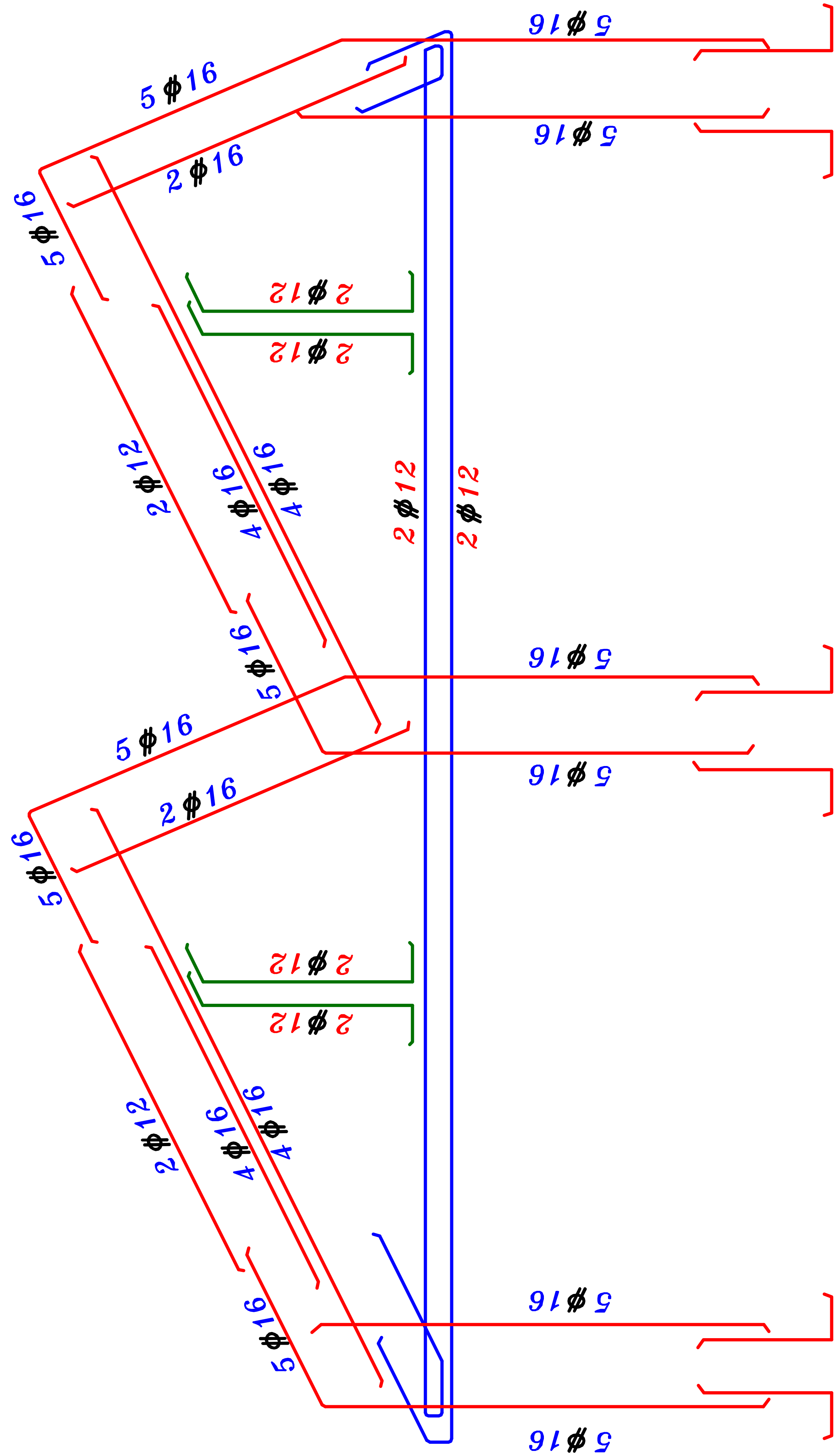
$$As_{min} = \frac{0.25 + 0.052\, \lambda_{max}}{100} * b * t$$

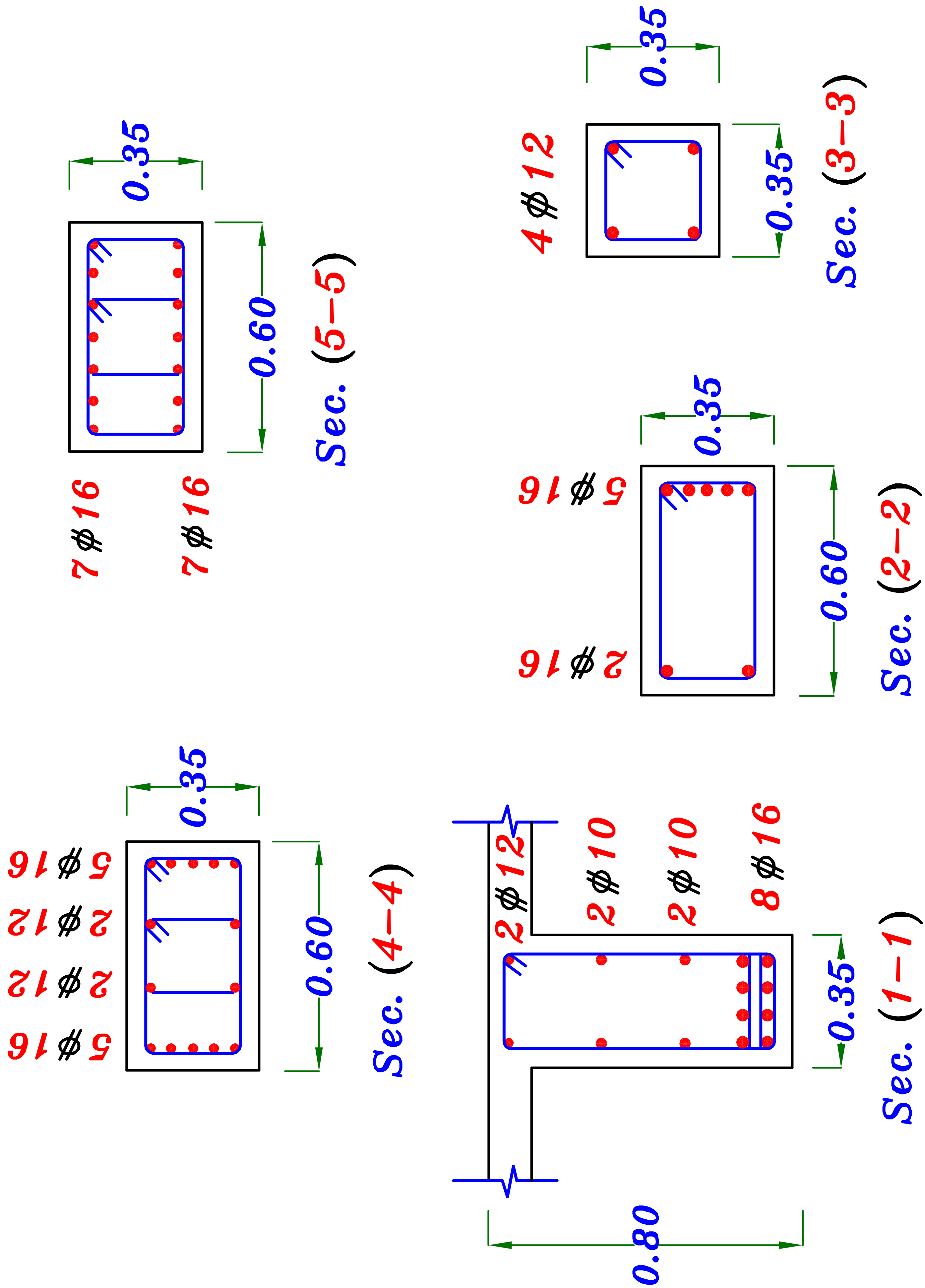
$$= \frac{0.25 + 0.052\,(20.57)}{100} * 600 * 350 = 2771 \ mm^2 > As_{total}$$

$$As = As` = \frac{2771}{2} = 1385 \ mm^2 \qquad 7\phi16$$

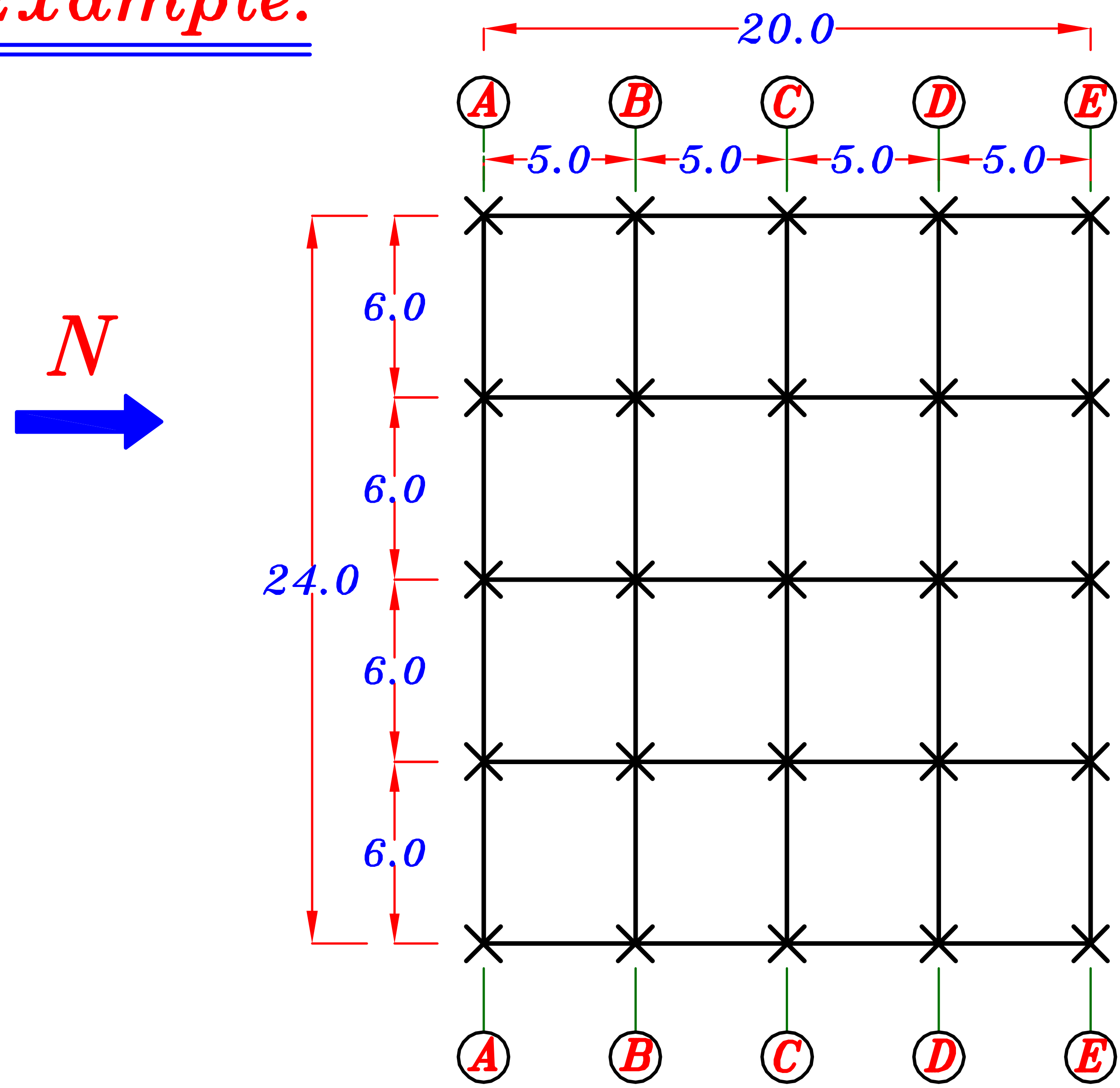





5 ϕ 16
5 ϕ 16
2 ϕ 16
5 ϕ 16
5 ϕ 16
2 ϕ 12
2 ϕ 12
2 ϕ 12
4 ϕ 16
4 ϕ 16
2 ϕ 12
2 ϕ 12
5 ϕ 16
5 ϕ 16
5 ϕ 16
2 ϕ 16
5 ϕ 16
5 ϕ 16
2 ϕ 12
2 ϕ 12
2 ϕ 12
4 ϕ 16
4 ϕ 16
5 ϕ 16
5 ϕ 16
5 ϕ 16


Sec. (5-5)
0.35
0.60
7 ϕ 16
7 ϕ 16
Sec. (3-3)
0.35
0.35
4 ϕ 12
Sec. (2-2)
0.35
0.60
5 ϕ 16
2 ϕ 16
Sec. (4-4)
0.35
0.60
5 ϕ 16
2 ϕ 12
2 ϕ 12
5 ϕ 16
Sec. (1-1)
0.35
0.80
2 ϕ 12
2 ϕ 10
2 ϕ 10
8 ϕ 16

Example.



Req.

For the given Plan.

1 – Without any calculation but with reasonably assumed concrete dimensions Draw to scale 1:50 in elevation and plan concrete dimensions of the main supporting elements including Foundations.

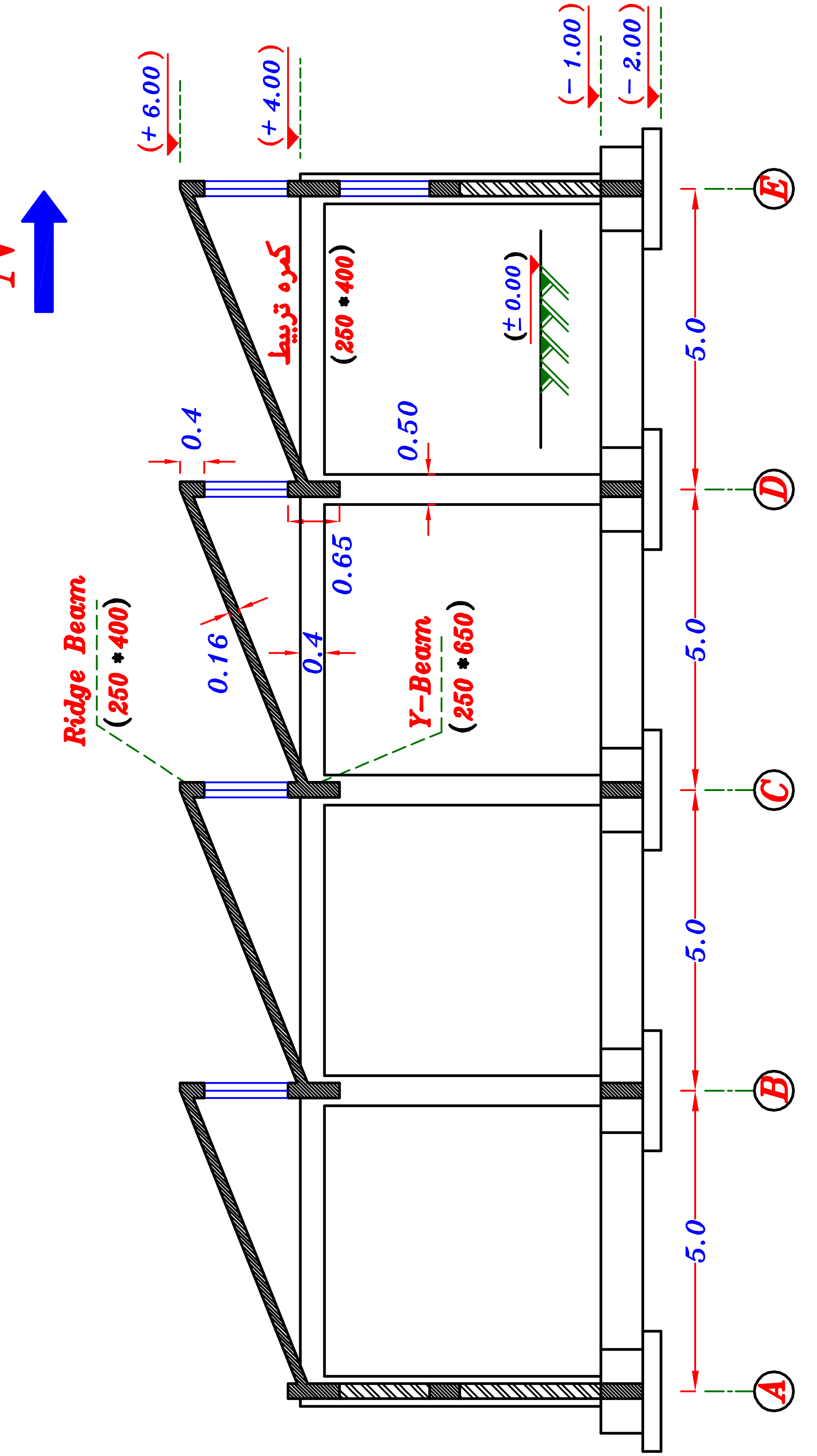
2 – IF the columns on axis B & D are removed

Draw to scale 1:50 in elevation and plan concrete dimensions of the main supporting elements including Foundations.

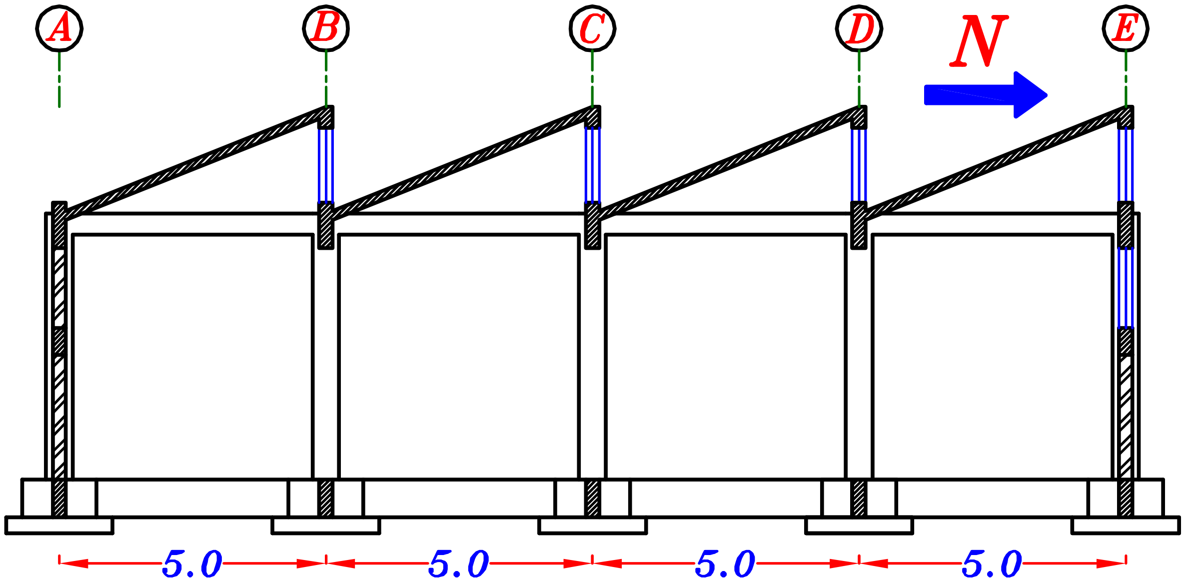
3 – IF the columns on axis B, C & D are removed

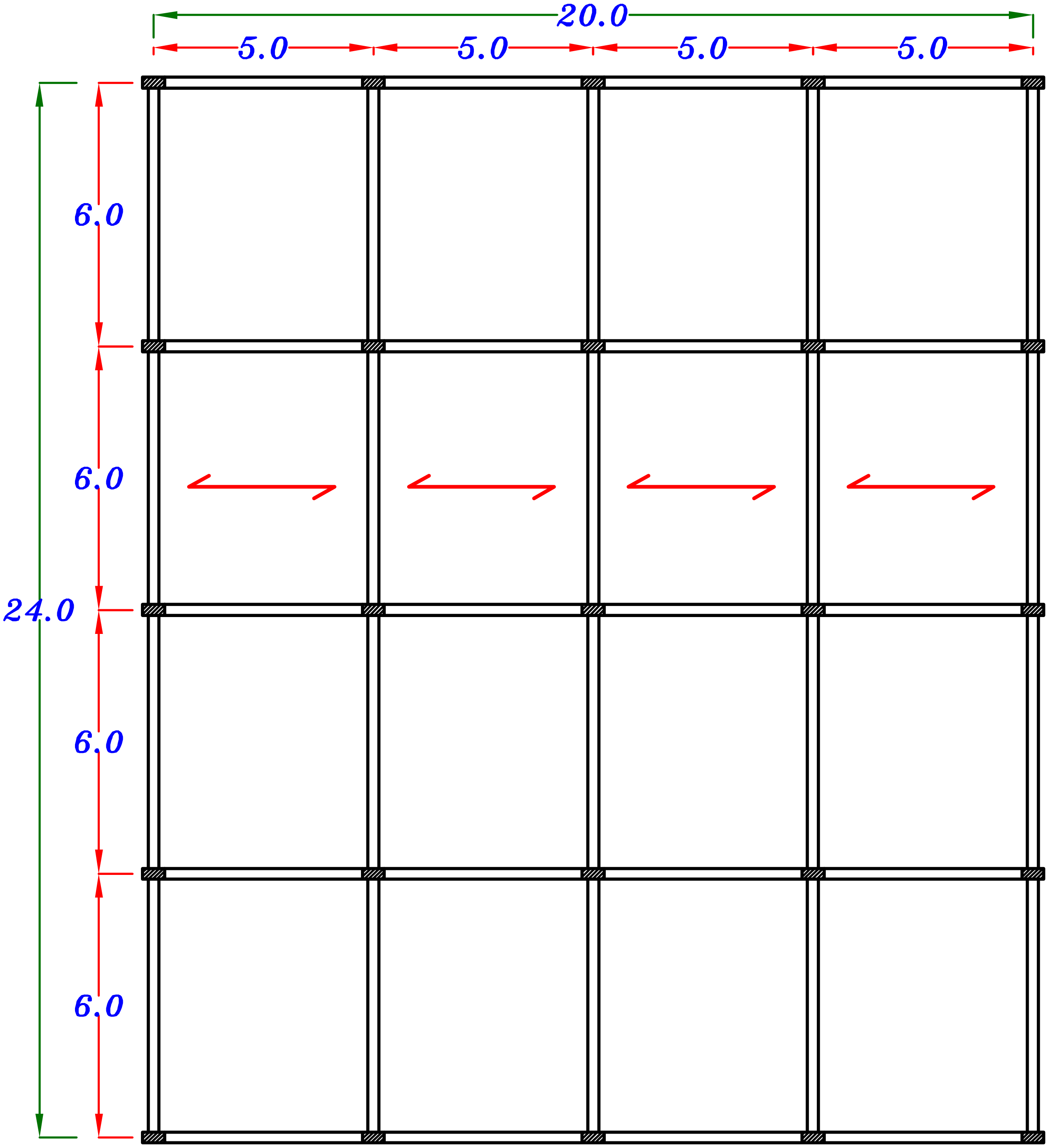
Draw to scale 1:50 in elevation and plan concrete dimensions of the main supporting elements including Foundations.

① Saw Tooth Slab Type rested on columns.

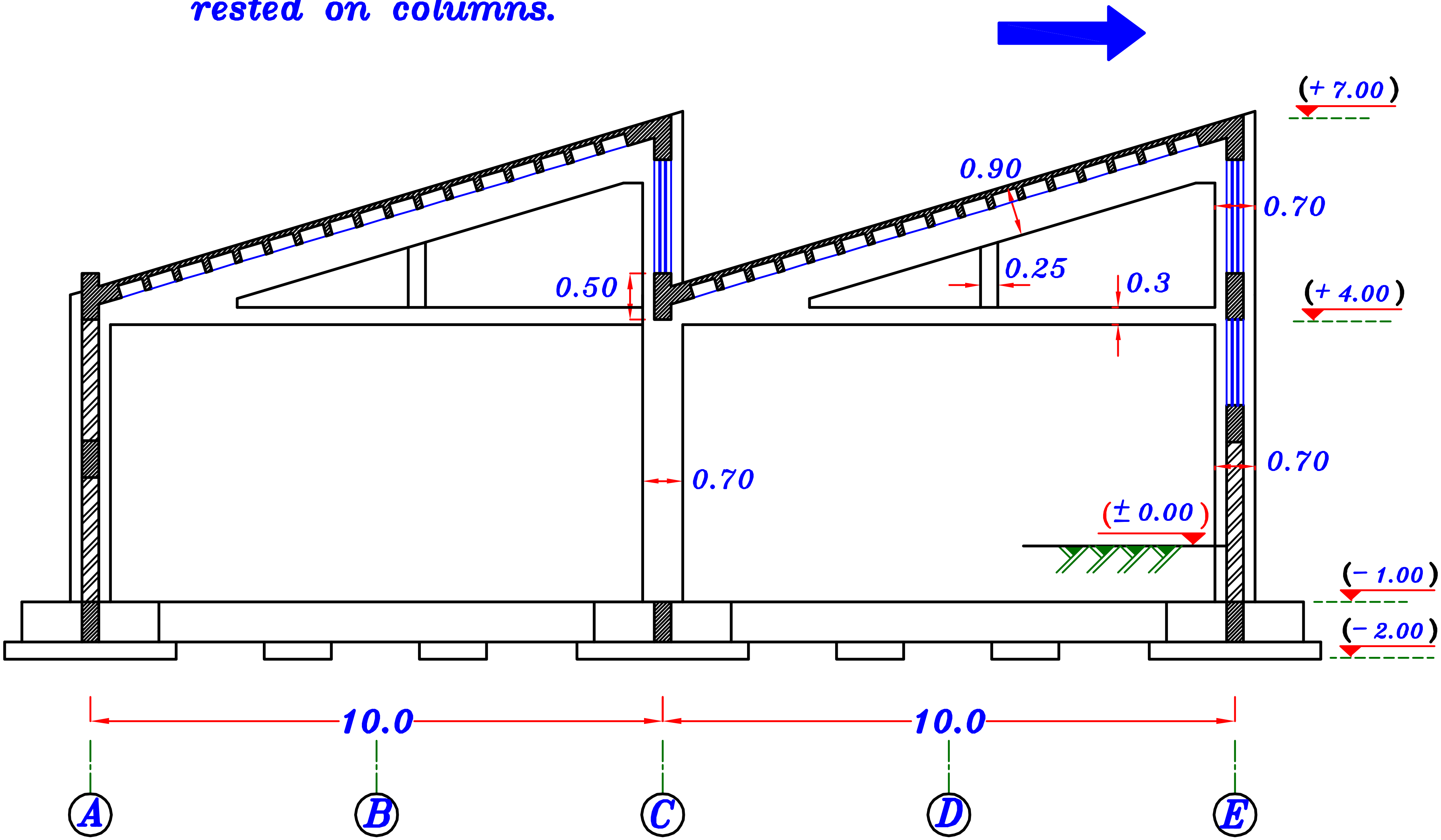


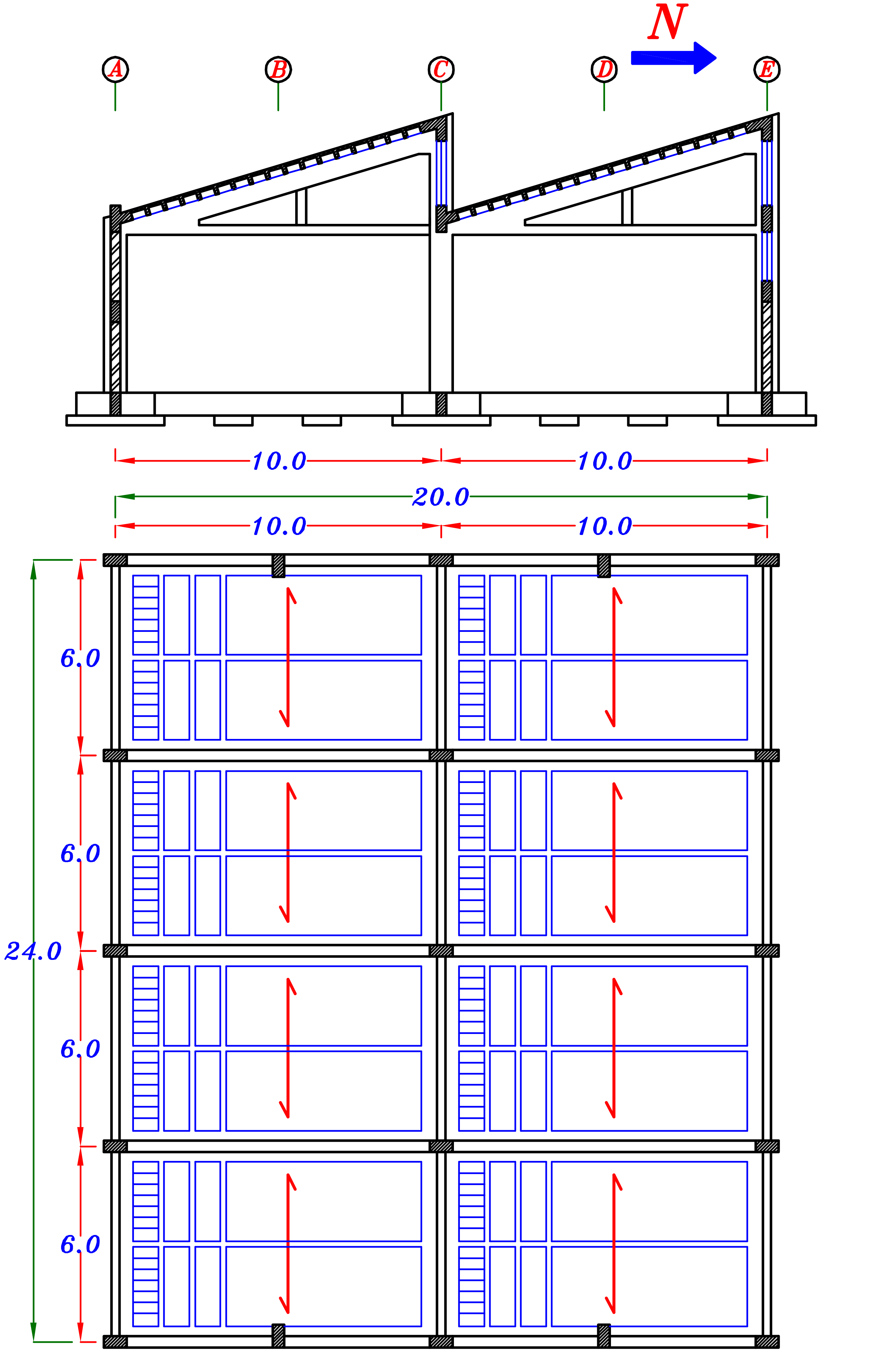
Elevation


A
B
C
D
N
E
5.0
5.0
5.0
5.0


20.0
5.0
5.0
5.0
5.0
6.0
6.0
6.0
6.0
24.0

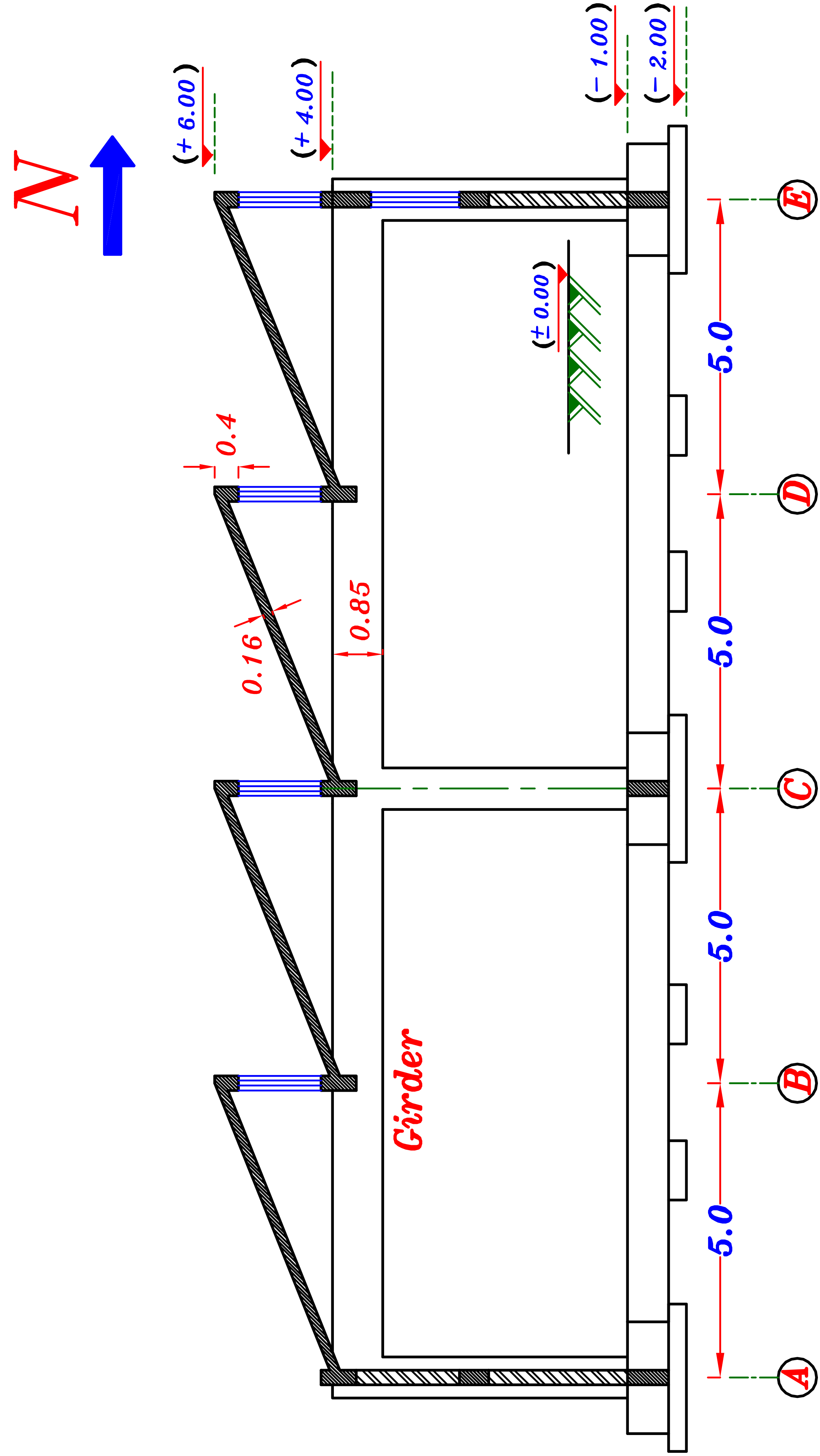
② Saw Tooth Girder Type rested on columns.

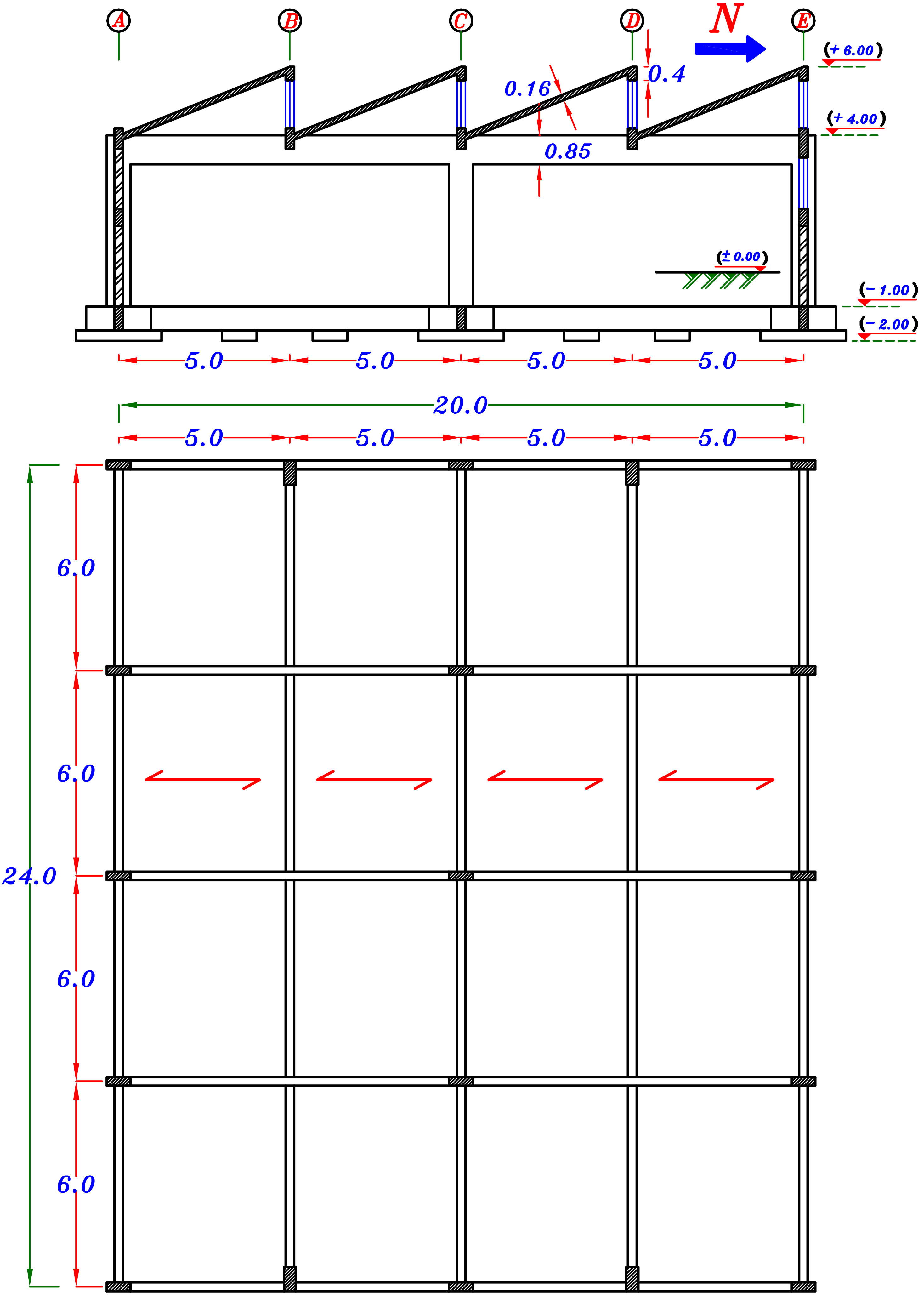



N
A
B
C
D
E
10.0
10.0
20.0
10.0
10.0
6.0
6.0
6.0
6.0
24.0

② Saw Tooth Slab Type rested on Girder.

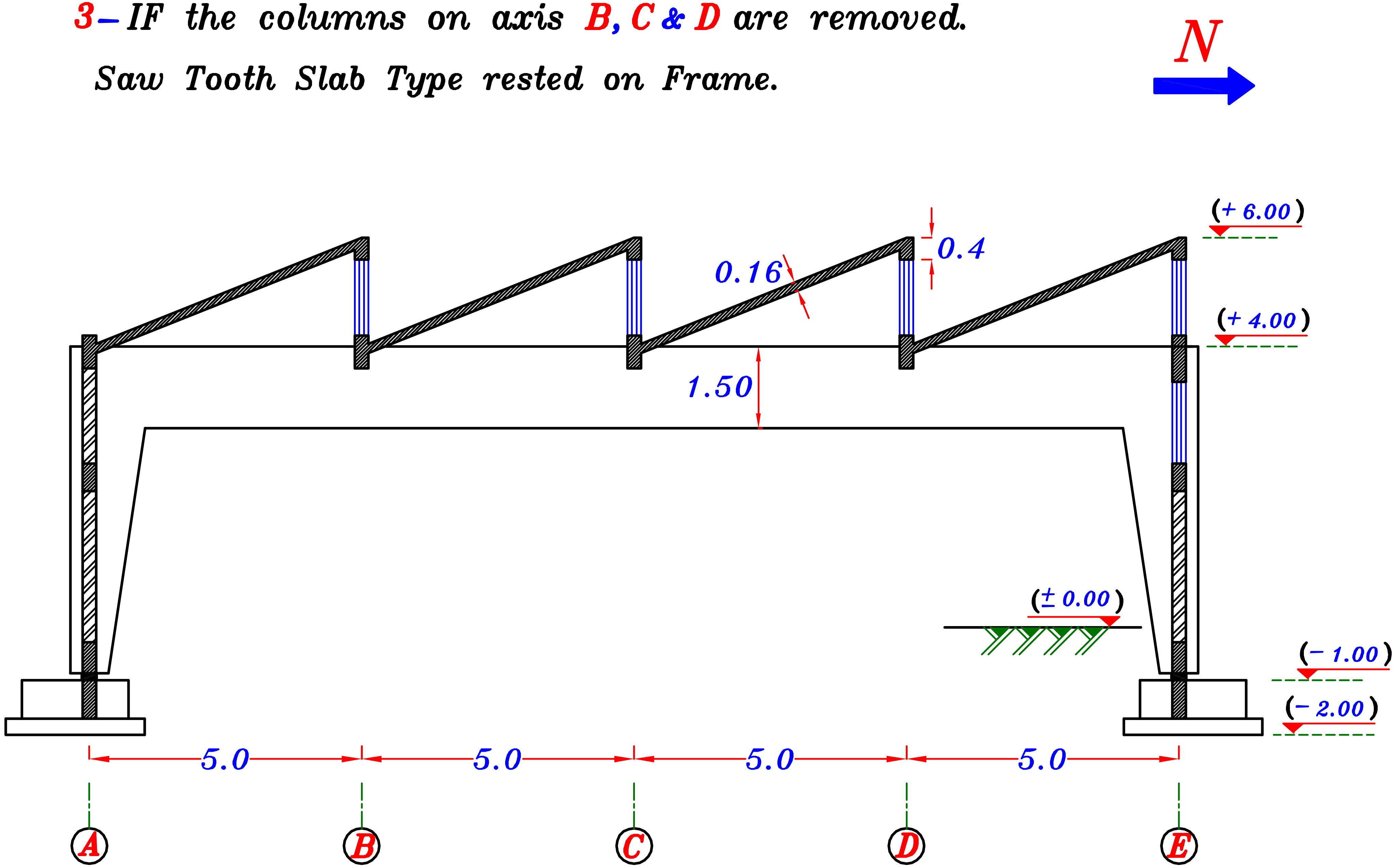
ممكن أخذ البلاطه Slab Type محموله على Girder

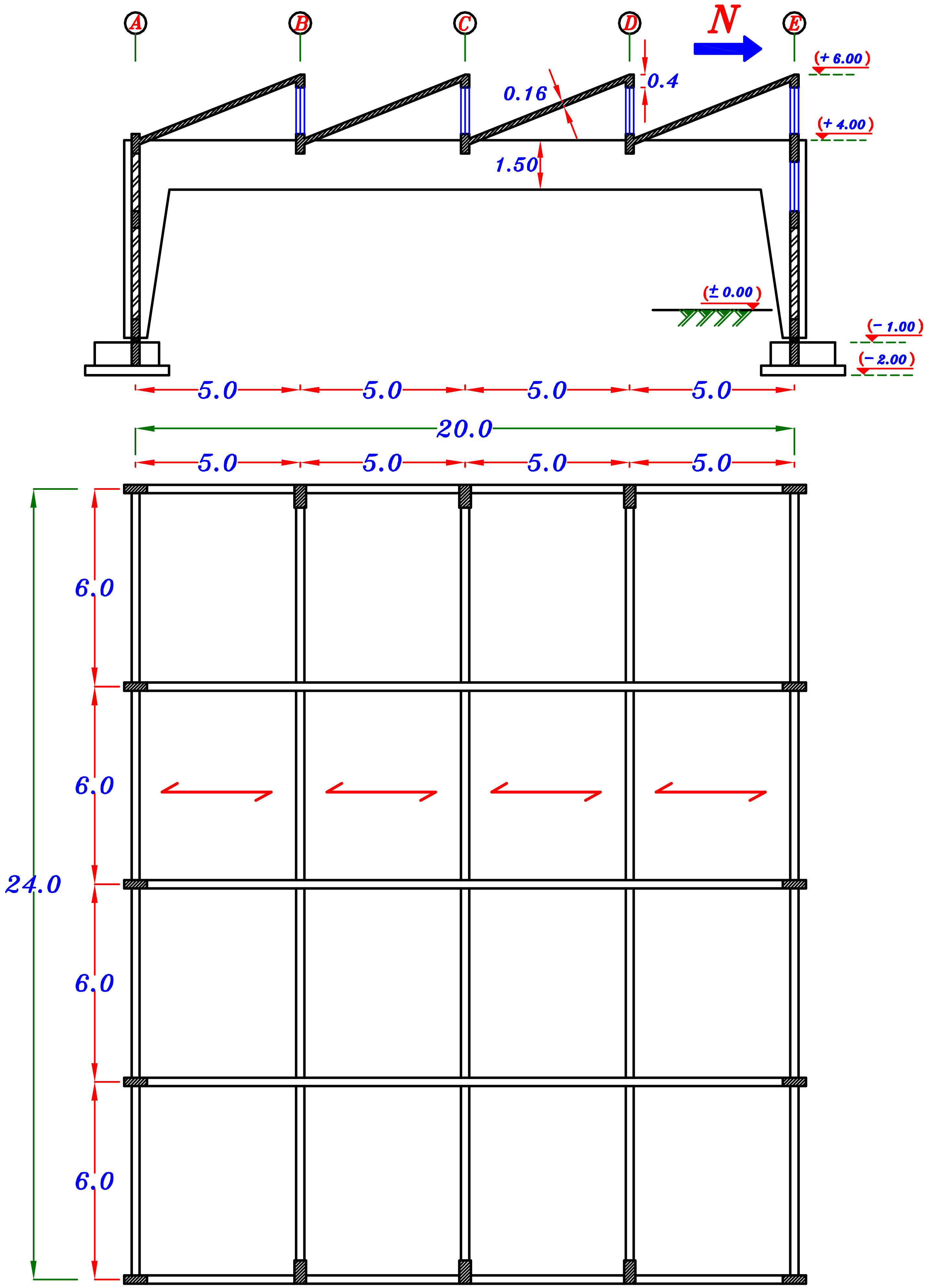



A
B
C
D
E
N
(+ 6.00)
(+ 4.00)
0.16
0.4
0.85
(± 0.00)
(− 1.00)
(− 2.00)
5.0
5.0
5.0
5.0
20.0
5.0
5.0
5.0
5.0
6.0
6.0
24.0
6.0
6.0

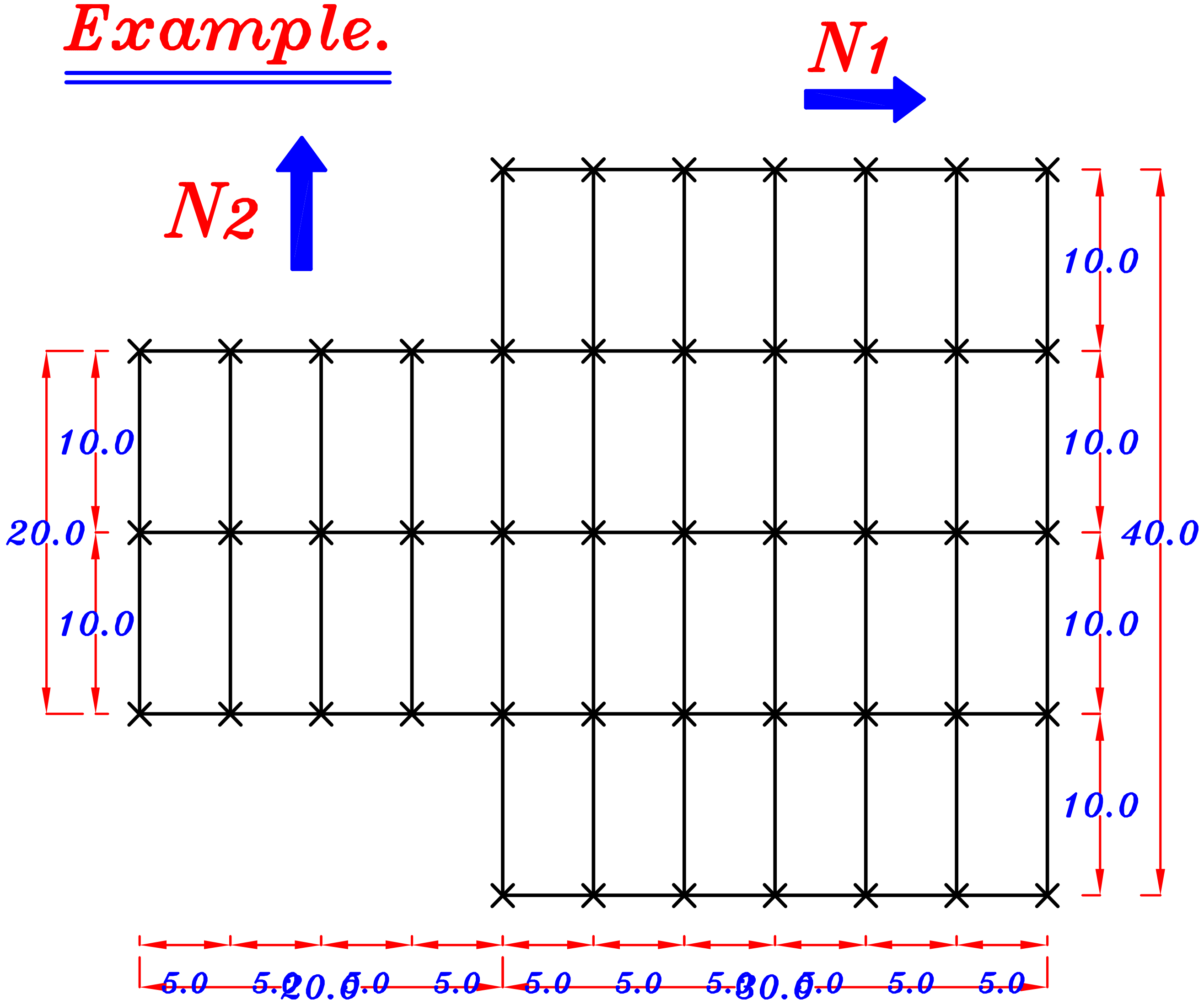
3– IF the columns on axis B, C & D are removed.

Saw Tooth Slab Type rested on Frame.




A
B
C
D
E
N
(+ 6.00)
(+ 4.00)
0.4
0.16
1.50
(± 0.00)
(− 1.00)
(− 2.00)
5.0
5.0
5.0
5.0
20.0
5.0
5.0
5.0
5.0
6.0
6.0
6.0
6.0
24.0

Example.



$F_{cu.} = 25$ N\mm^2 , $F_y = 360$ N\mm^2

L.L. = 1.0 kN\m^2 , F.C. = 1.0 kN\m^2

Saw Tooth Start at level + 4.00 m

Foundations Level = − 2.0 m

Req.

For the given Plan.

1- For north direction N1

a- Draw concrete dimensions (Elevation, Plan & Side view)

b - Design the slabs and draw RFT. in the plan.

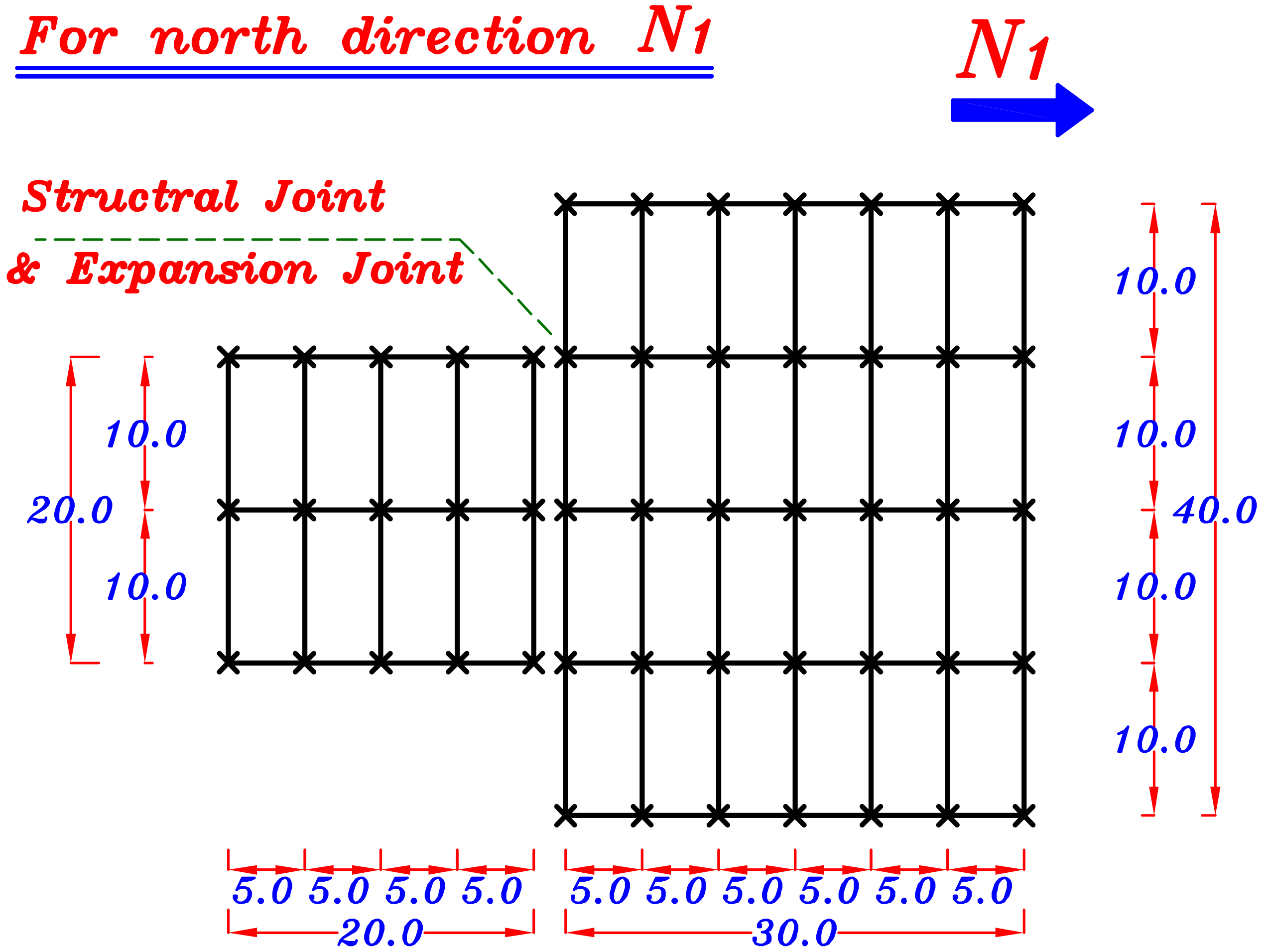
c - Design all concrete elements (Beams, columns & main system)

d- Draw details of RFT. For all elements.

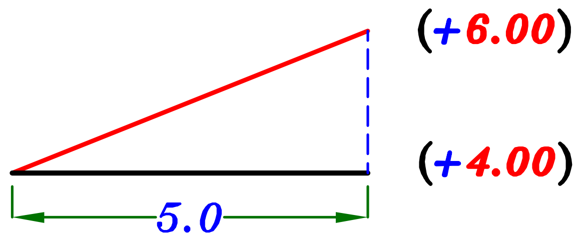
2- For north direction N2

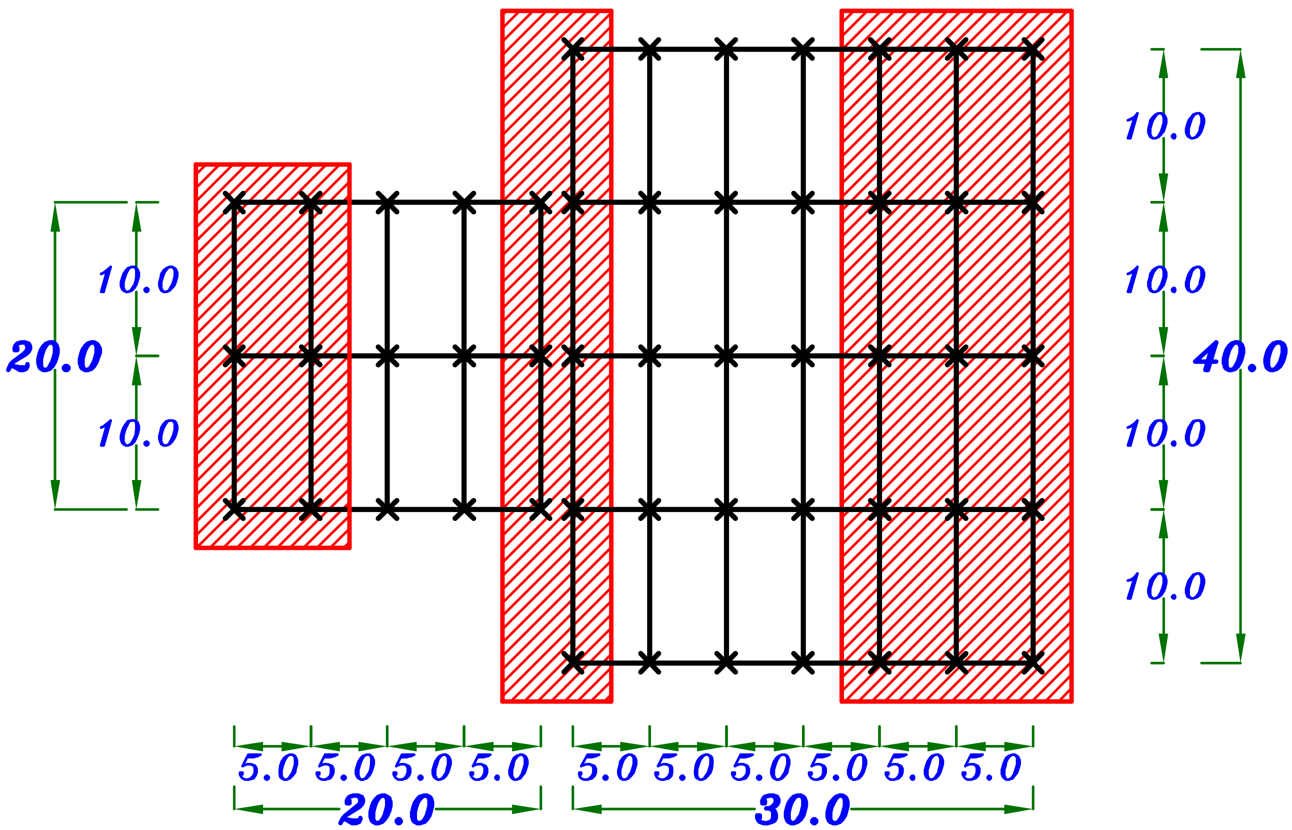
The same requirements as direction N1

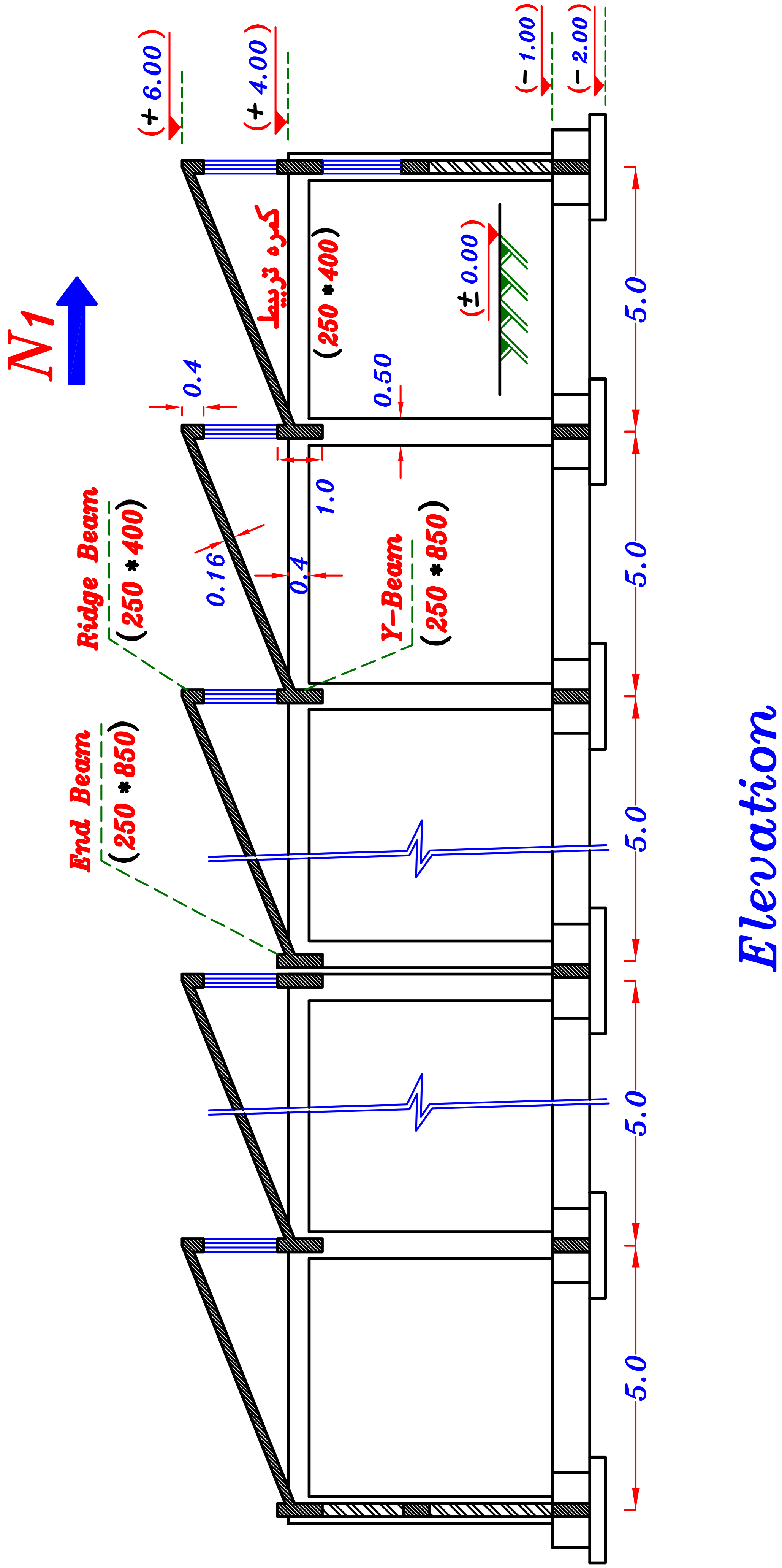
For north direction N_1

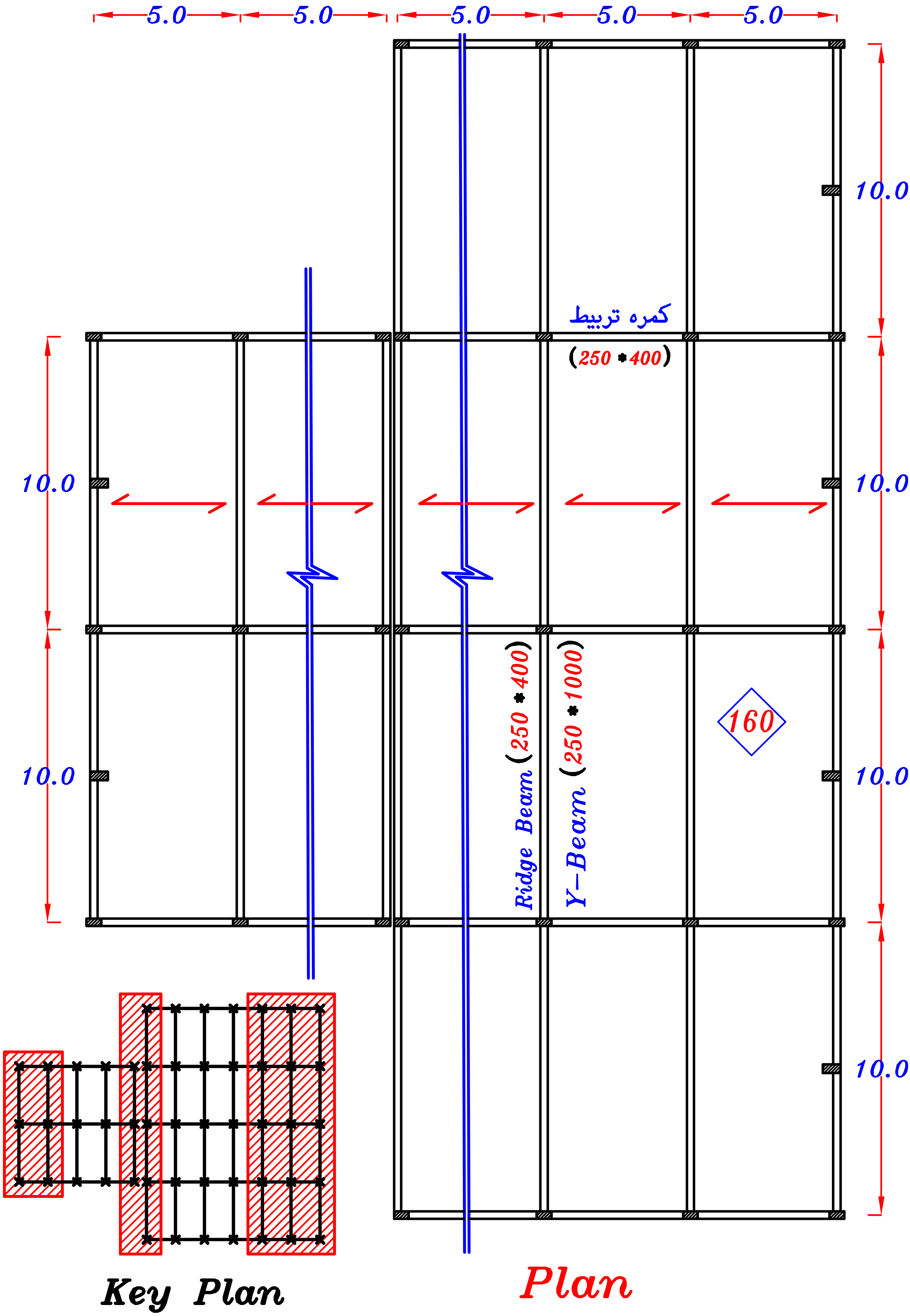


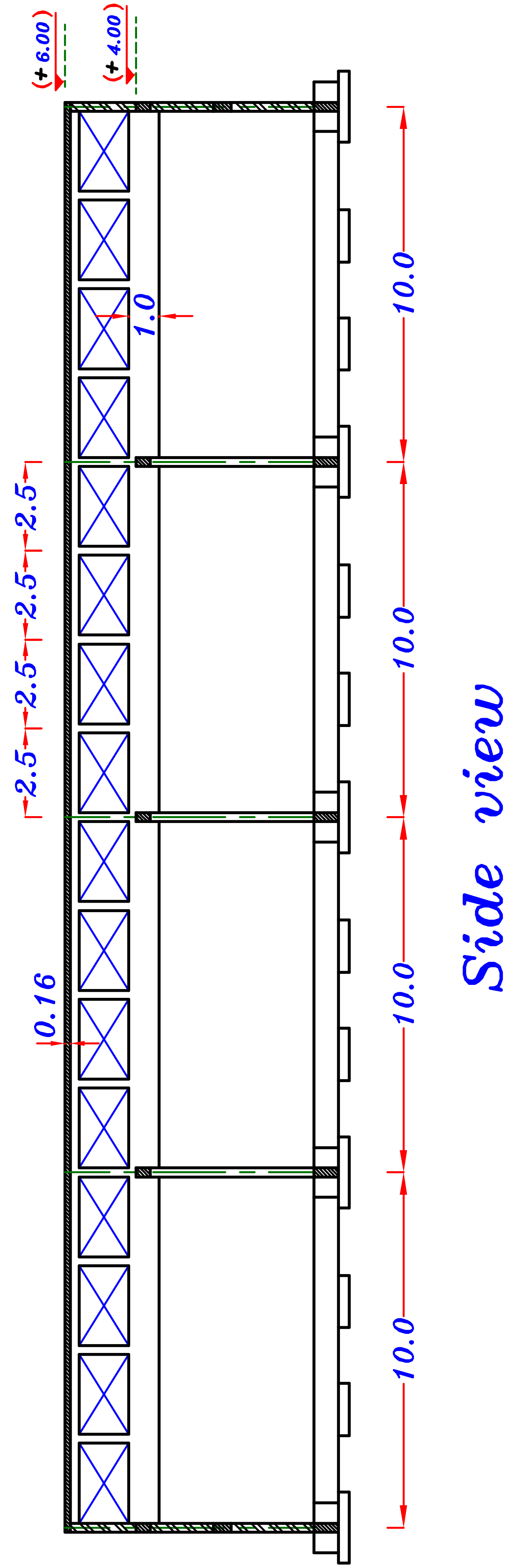
Use Saw tooth slab type

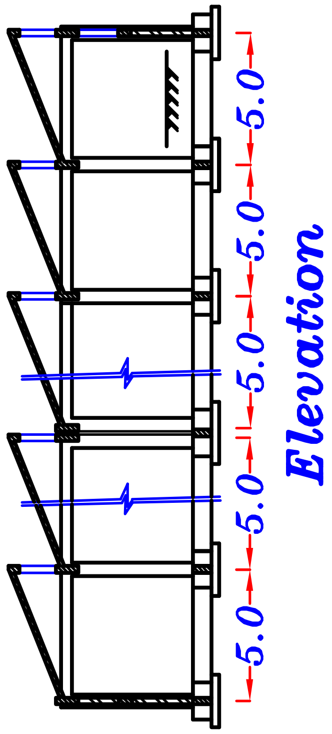


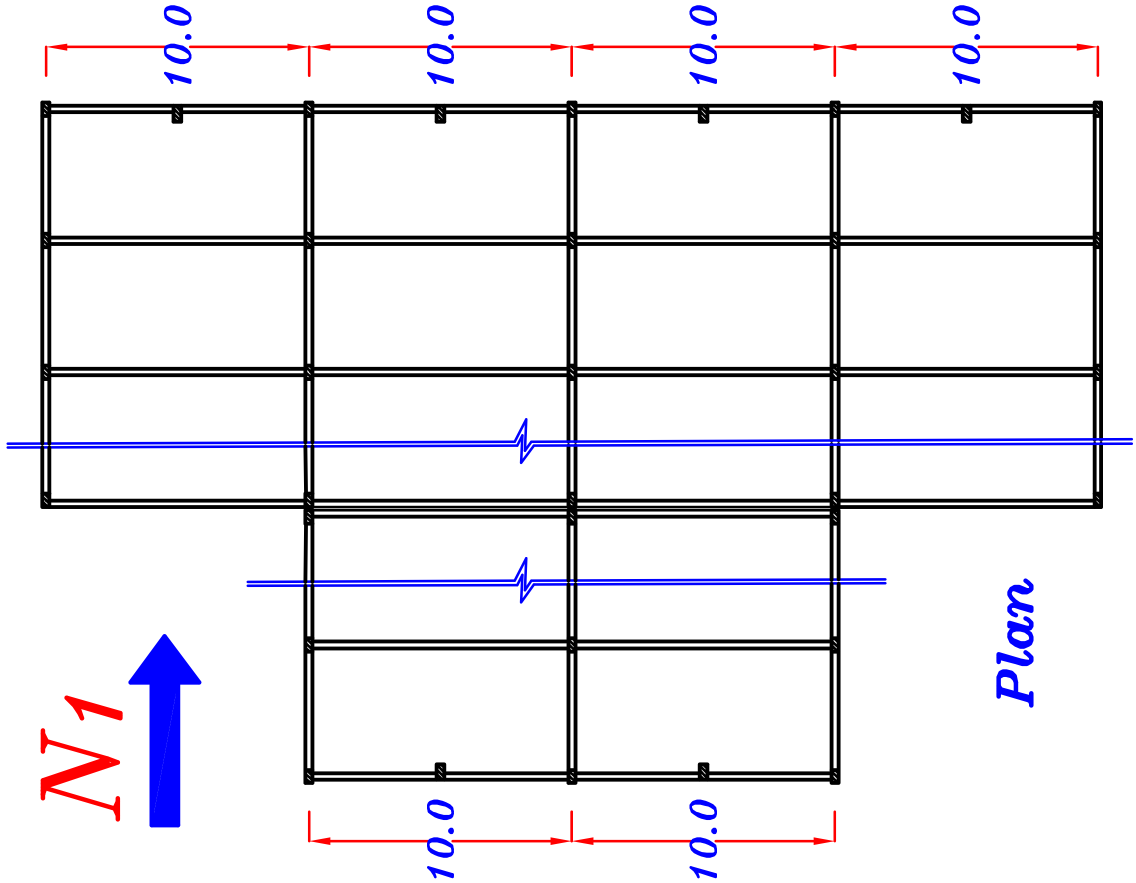


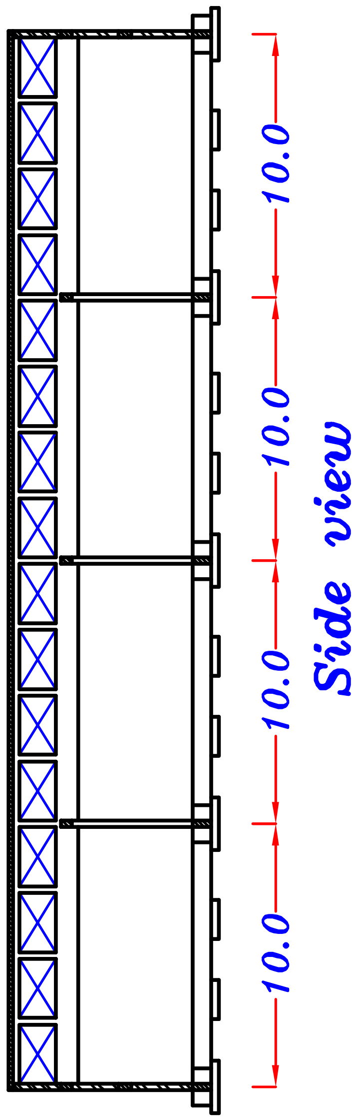

N1
Elevation
(+ 6.00)
(+ 4.00)
(− 1.00)
(− 2.00)
(± 0.00)
Ridge Beam
(250 * 400)
End Beam
(250 * 850)
Y-Beam
(250 * 850)
كمره تربيط
(250 * 400)
0.4
0.16
0.4
1.0
0.50
5.0
5.0
5.0
5.0
5.0
5.0

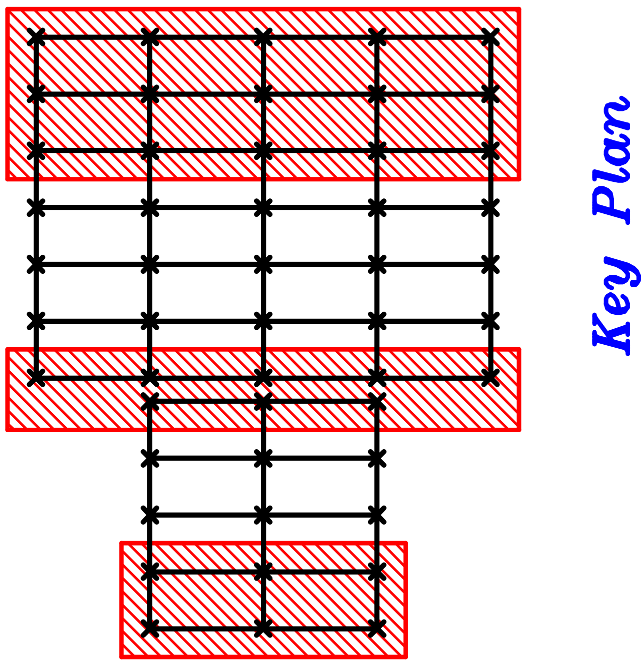

5.0
5.0
5.0
5.0
5.0
10.0
10.0
10.0
10.0
10.0
10.0
كمره تربيط
(250 * 400)
Ridge Beam (250 * 400)
Y-Beam (250 * 1000)
160
Key Plan
Plan


(+ 6.00)
(+ 4.00)
1.0
10.0
10.0
10.0
10.0
2.5
2.5
2.5
2.5
0.16
Side view


5.0
5.0
5.0
5.0
5.0
Elevation


10.0
10.0
10.0
10.0
N1
10.0
10.0
Plan

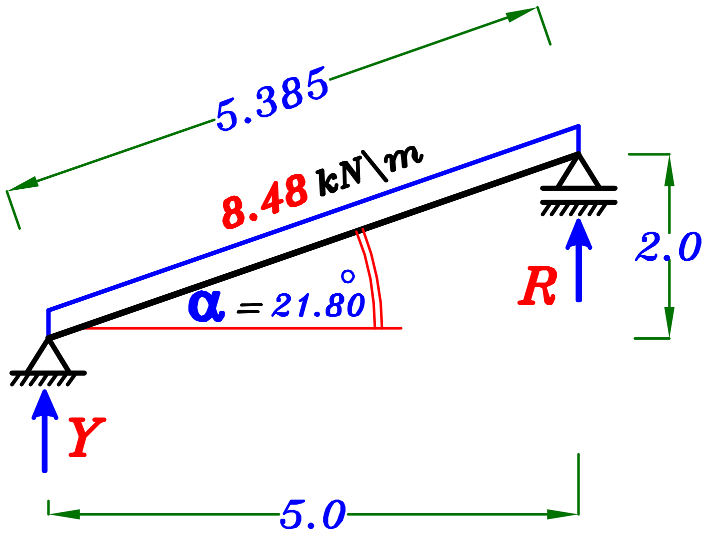

10.0
10.0
10.0
10.0
Side view


Key Plan

Slabs.

$$t_s = \frac{5385}{35} = 153.8 \text{ mm}$$

Take $\boxed{t_s = 160 \text{ mm}}$



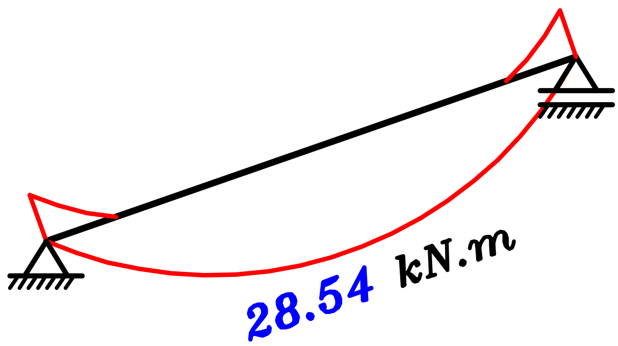
$$(w_s)_i = 1.4\,(0.16 * 25 + 1.0) + 1.6\,(1.0)\, \cos 21.80^\circ = 8.48 \text{ kN\textbackslash m}^2$$

$$R = Y = \frac{w L'}{2} = \frac{8.48 * 5.385}{2} = 22.83 \text{ kN}$$

Design of slab.

$$M = \frac{w L L'}{8} = \frac{8.48 * 5.0 * 5.385}{8}$$

$$= 28.54 \text{ kN.m}$$

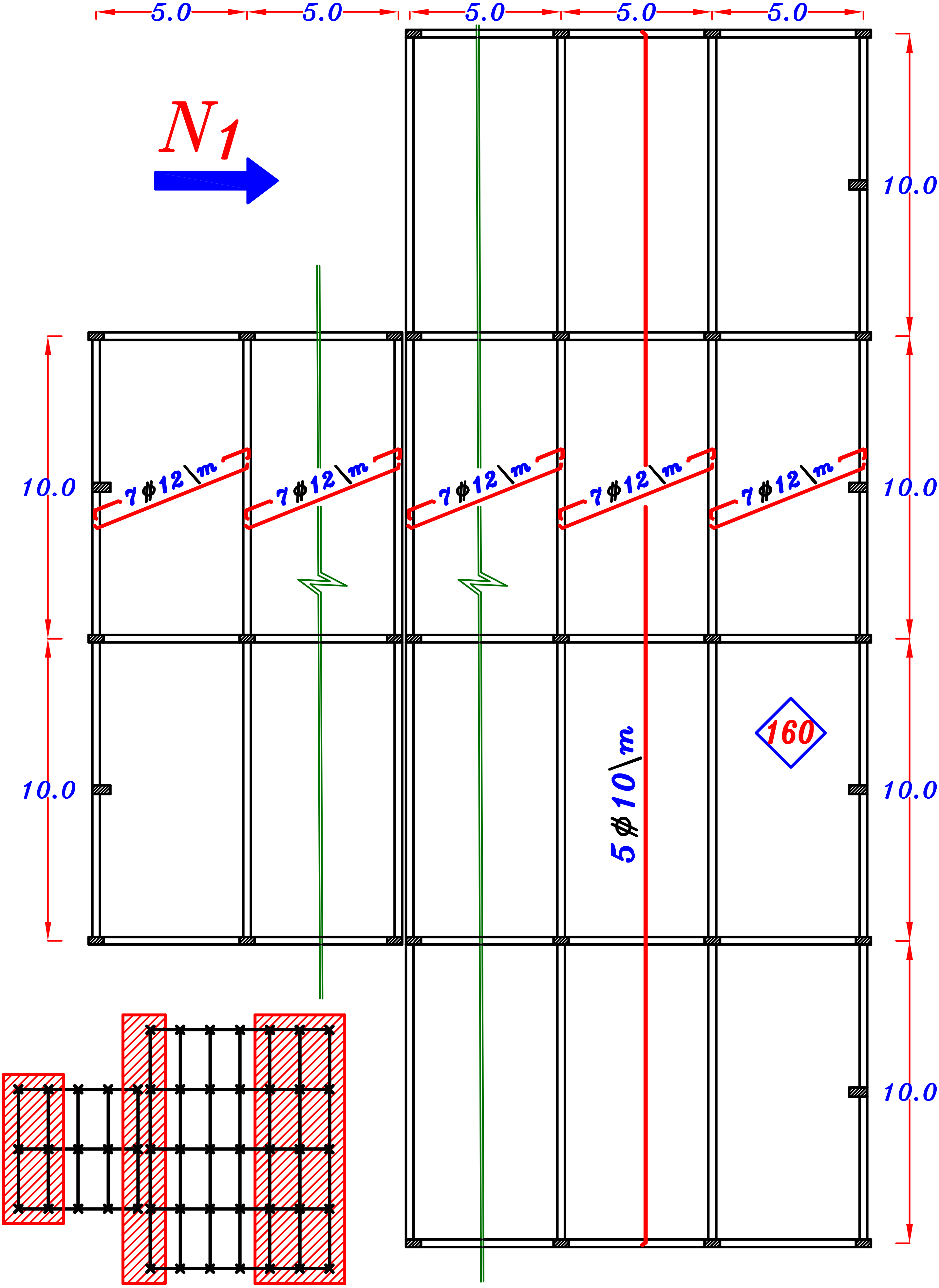


$t_s = 160$ mm , $d = 160 - 20 = 140$ mm

$$140 = C_1 \sqrt{\frac{28.54 * 10^6}{25 * 1000}}$$

$\longrightarrow C_1 = 4.14 \longrightarrow J = 0.808$

$$A_s = \frac{28.54 * 10^6}{0.808 * 360 * 140} = 700.83 \text{ mm}^2\text{\textbackslash m}$$ 7Φ12\m



Key Plan

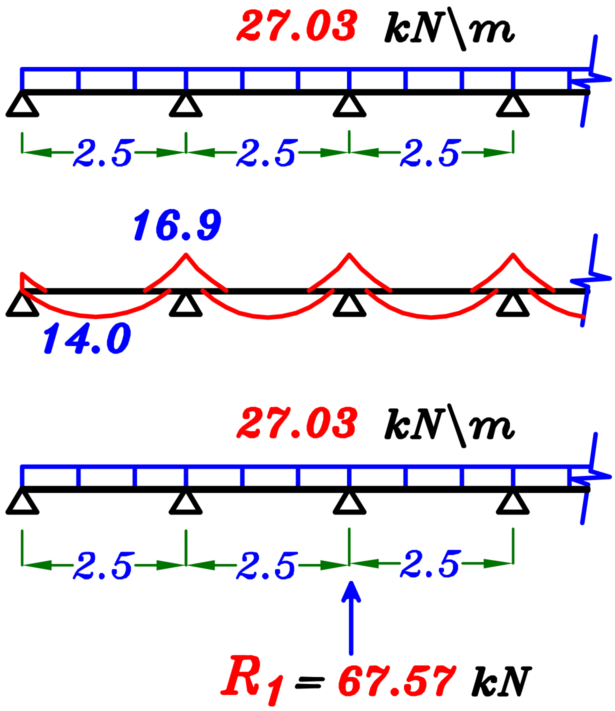
Plan

Ridge Beam. (250*400)

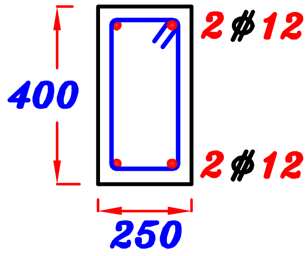
Distance between Posts. = 2.50 m.

w = O.W. (beam) + R

= 4.20 + 22.83 = 27.03 kN\m



A_s = 2 ϕ 12



$R_1 = w * a$

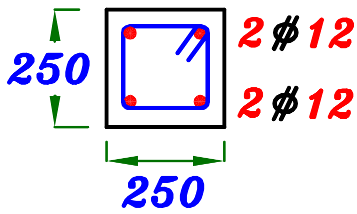
= 27.03 * 2.5 = 67.57 kN

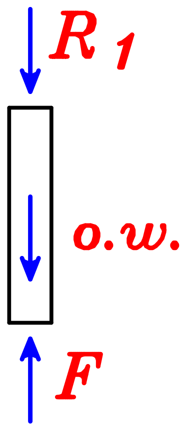
Post. (250*250)

F = O.W. (Post) + R_1

= 3.50 + 67.57 = 71.07 kN

A_s = 4 ϕ 12



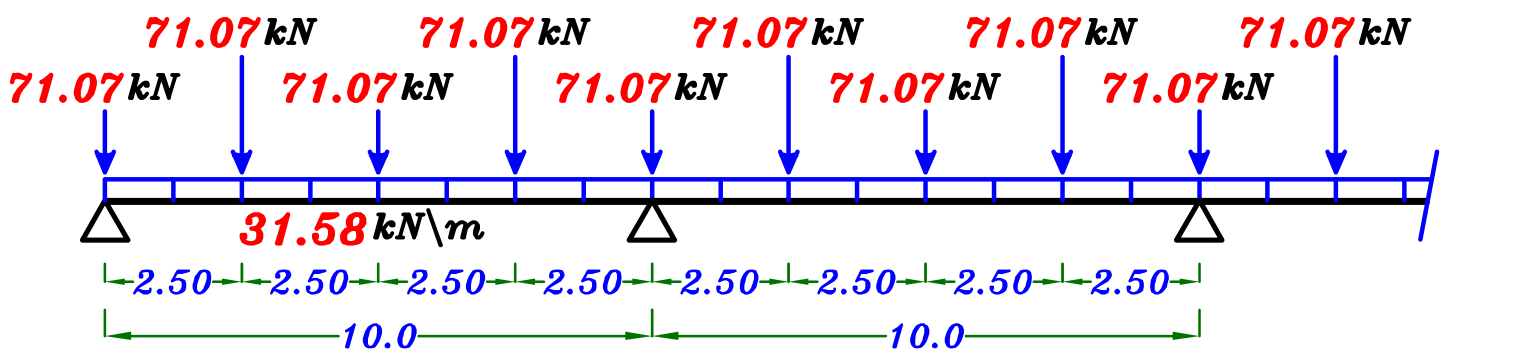


Y-Beam. (250*1000)

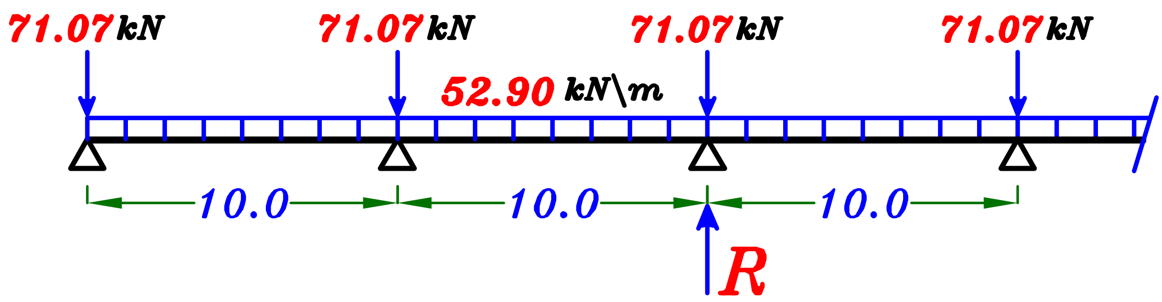
$$t_{Y\text{-beam}} = \frac{\text{Spacing}}{12} + 150 \text{ mm} = \frac{10000}{12} + 150 = 983 = 1000 \text{ mm}$$

$$\text{o.w.}(\text{Y-Beam}) = b\, t\, \gamma_c * 1.4 = (0.25 * 1.0 * 25) * 1.4 = 8.75 \text{ kN\\m}$$

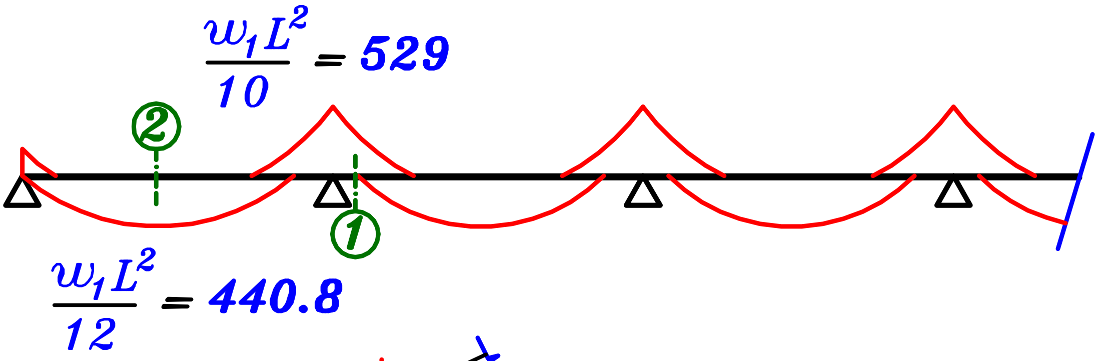
$$w = \text{o.w.} + Y = 8.75 + 22.83 = 31.58 \text{ kN\\m}$$



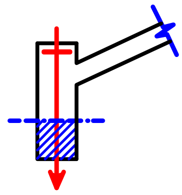
$$w_1 = w + \frac{\sum F}{Span} = 31.58 + \frac{3.0 * 71.07}{10.0} = 52.90 \ kN\backslash m$$



$$R = w_1 * S + F = 52.90 * 10.0 + 71.07 = 600.07 \ kN$$



Sec.1 R-sec.



$t = 1000$ mm , $d = 950$ mm

$$950 = C_1 \sqrt{\frac{529.0 * 10^6}{25 * 250}} \longrightarrow C_1 = 3.26 \longrightarrow J = 0.765$$

$$A_s = \frac{529.0 * 10^6}{0.765 * 360 * 950} = 2021.9 \ mm^2$$

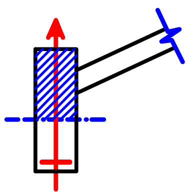
Check $A_{s\,min.}$ $A_{s_{req.}} = 2021.9 \ mm^2$

$$\mu_{min.} \, b \, d = \left(0.225 * \frac{\sqrt{F_{cu}}}{F_y}\right) b \, d = \left(0.225 * \frac{\sqrt{25}}{360}\right) 250 * 950 = 742.2 \ mm^2$$

$\therefore A_{s_{req.}} > \mu_{min.} b \, d$ $\therefore$ Take $A_s = A_{s_{req.}} = 2021.9 \ mm^2$ **6 ϕ22**

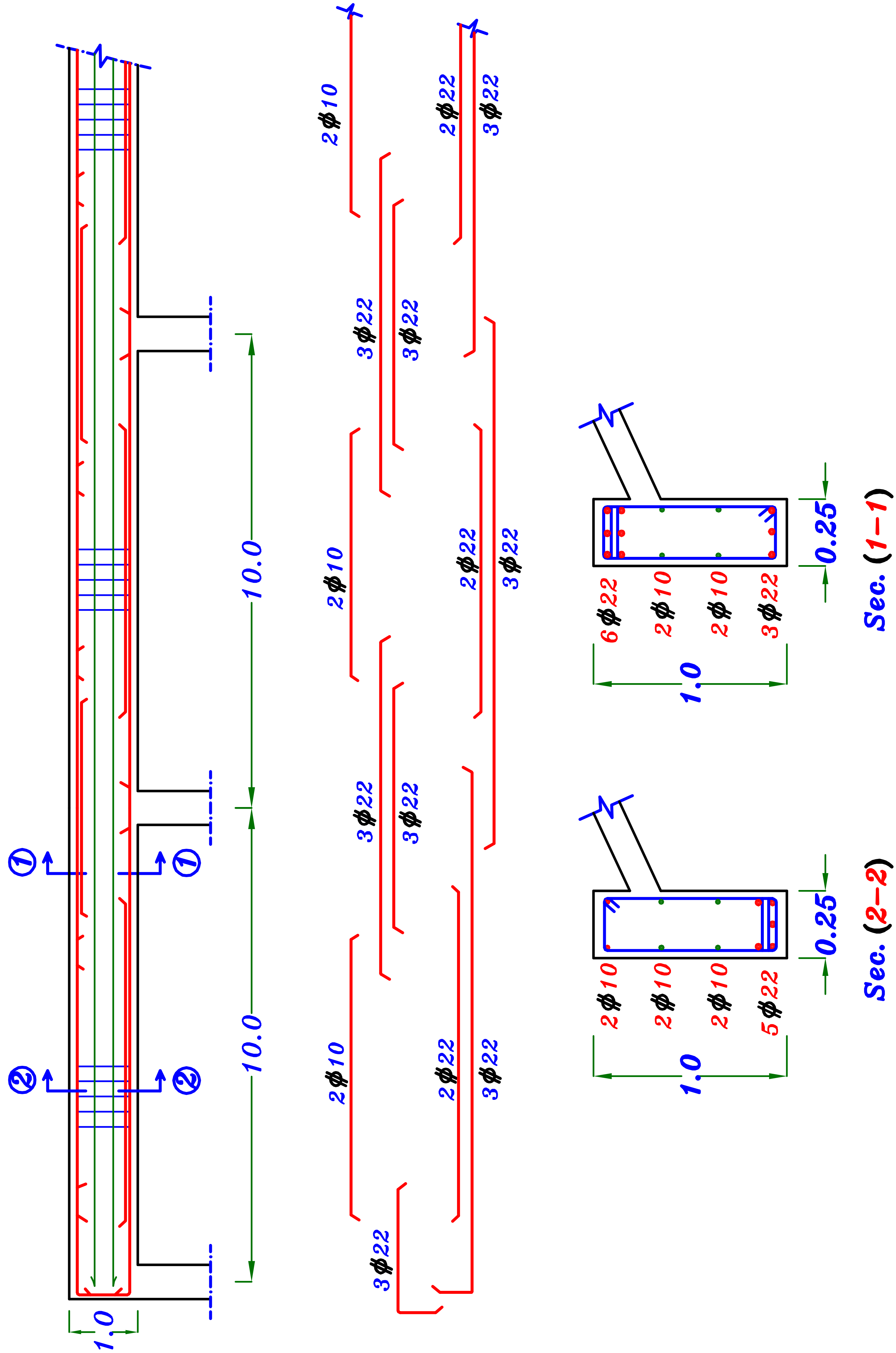
$$\therefore n = \frac{b - 25}{\phi + 25} = \frac{250 - 25}{22 + 25} = 4.78 = 4.0 \text{ bars}$$

Sec.2 R-sec.



5 ϕ22

RFT. of Y-Beam.



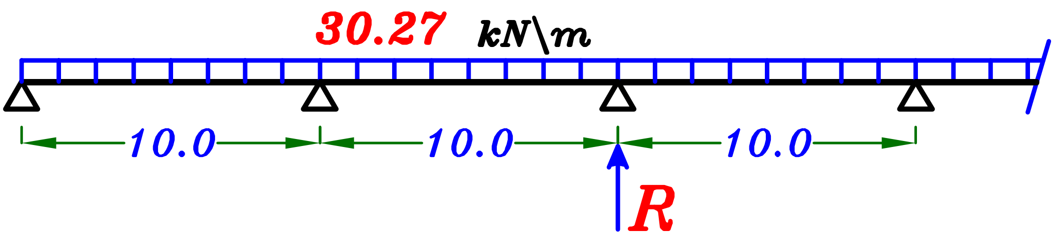
1.0
10.0
10.0
① ①
② ②
2ϕ10
3ϕ22
3ϕ22
2ϕ22
3ϕ22
2ϕ10
2ϕ22
3ϕ22
3ϕ22
3ϕ22
2ϕ10
2ϕ22
3ϕ22
3ϕ22
6ϕ22
2ϕ10
2ϕ10
3ϕ22
1.0
0.25
Sec. (1–1)
2ϕ10
2ϕ10
2ϕ10
5ϕ22
1.0
0.25
Sec. (2–2)

End Beam. (250*850)

$$t = \frac{Spacing}{12} = \frac{10000}{12} = 833 = 850 \text{ mm}$$

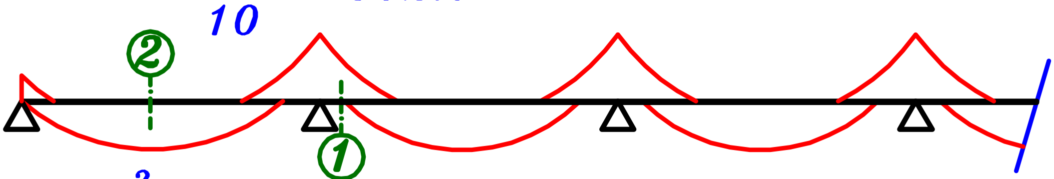
$$o.w. = b\,t\,\gamma_c * 1.4 = (0.25 * 0.85 * 25) * 1.4 = 7.44 \text{ kN\m}$$

$$w = o.w. + Y = 7.44 + 22.83 = 30.27 \text{ kN\m}$$



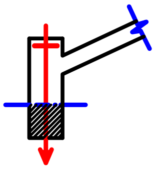
$$R = w * S = 30.27 * 10.0 = 302.7 \text{ kN}$$

$$\frac{w\,L^2}{10} = 302.7$$



$$\frac{w\,L^2}{12} = 252.2$$

Sec.1 R-sec.



$t = 850$ mm , $d = 800$ mm

$$800 = C_1\sqrt{\frac{302.7 * 10^6}{25 * 250}} \longrightarrow C_1 = 3.63 \longrightarrow J = 0.786$$

$$A_s = \frac{302.7 * 10^6}{0.786 * 360 * 800} = 1337.2 \text{ mm}^2$$

Check $A_{s\,min.}$

$$A_{s_{req.}} = 1337.2 \text{ mm}^2$$

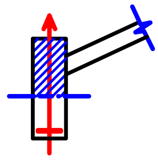
$$\mu_{min.}\,b\,d = \left(0.225 * \frac{\sqrt{F_{cu}}}{F_y}\right) b\,d = \left(0.225 * \frac{\sqrt{25}}{360}\right) 250 * 800 = 625 \text{ mm}^2$$

$$\therefore A_{s_{req.}} > \mu_{min.}\,b\,d \quad \therefore \text{Take } A_s = A_{s_{req.}} = 1337.2 \text{ mm}^2$$

4 ϕ22

$$\therefore n = \frac{b - 25}{\phi + 25} = \frac{250 - 25}{22 + 25} = 4.78 = 4.0 \text{ bars}$$

Sec.2 R-sec.

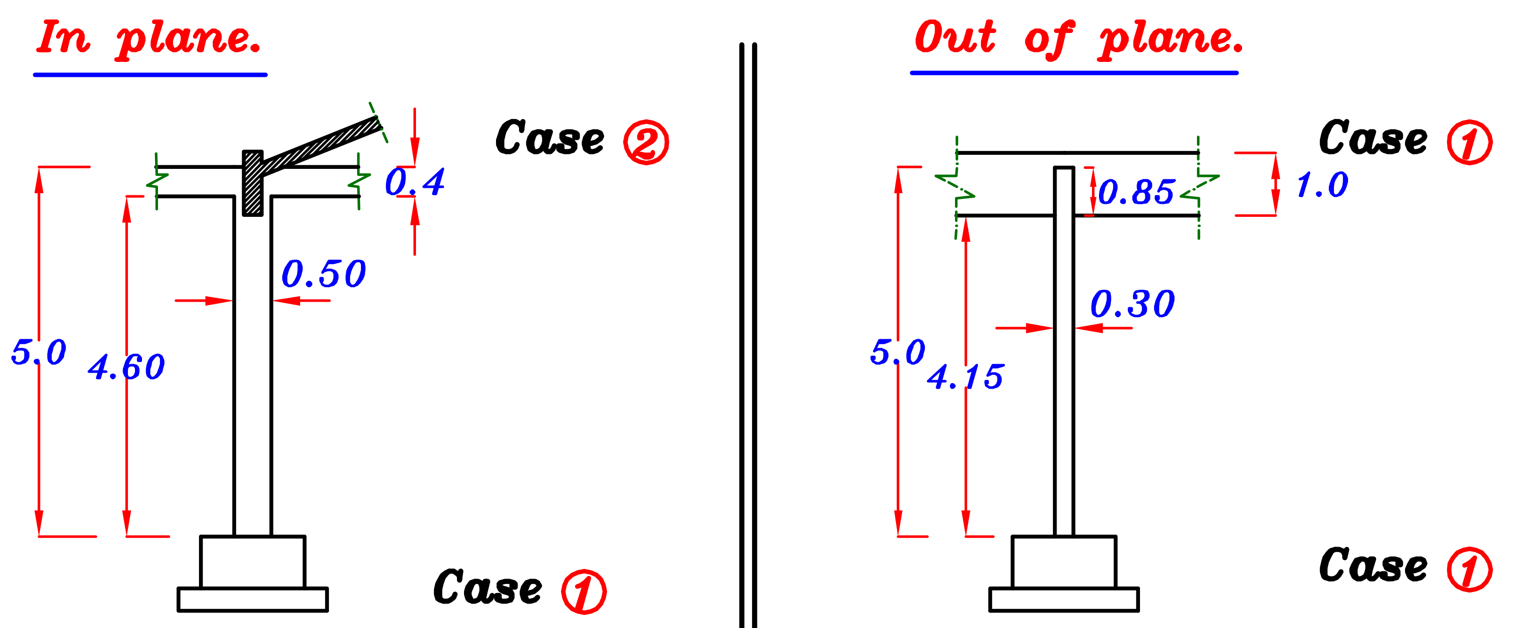


3 ϕ22

Loads on Column (300 * 500) عمود في الوسط

P = Reaction of Y–Beam = 713.1 kN

Check Buckling of the Column.



Upper Condition Case ②
Lower Condition Case ① } $k = 1.3$

$H_o = 4.60$ m

$$\lambda_b = \frac{1.3 * 4.60}{0.50} = 11.96 > 10$$

Upper Condition Case ①
Lower Condition Case ① } $k = 1.2$

$H_o = 4.15$ m

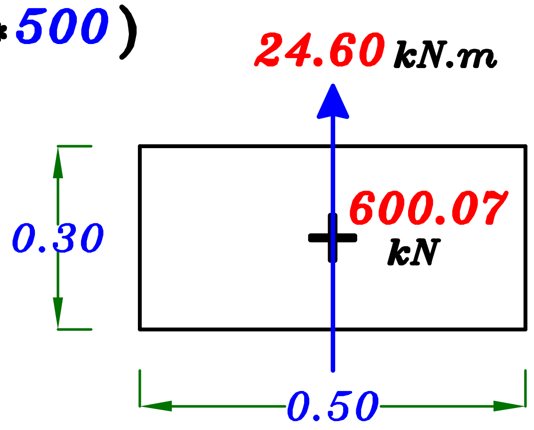
$$\lambda_b = \frac{1.2 * 4.15}{0.3} = 16.6 > 10$$

Take the bigger value of $\lambda_b = 16.6$ (Out of plane.)

$$\delta = \frac{(\lambda_b)^2 * b}{2000} = \frac{16.6^2 * 0.30}{2000} = 0.041 \text{ m}$$

$$M_{add.} = P * \delta = 600.07 * 0.041 = 24.60 \text{ kN.m}$$

Design of Column. (300 * 500)



$M = 24.60$ kN.m , $P = 600.07$ kN

Check $\frac{P}{F_{cu}\, b\, t} = \frac{600.07 * 10^3}{25 * 500 * 300} = 0.16 > 0.04$ (Don't neglect P)

$e = \frac{M}{P} = \frac{24.60}{600.07} = 0.041$ m $\therefore \frac{e}{t} = \frac{0.041}{0.30} = 0.136 < 0.5 \xrightarrow{use}$ I.D.

$\zeta = \frac{0.3 - 0.1}{0.3} = 0.67 \xrightarrow{use}$ Design Aids Page (4–25)

$$\left.\begin{array}{l} \frac{P_U}{F_{cu}\, b\, t} = \frac{600.07 * 10^3}{25 * 500 * 300} = 0.16 \\ \frac{M_U}{F_{cu}\, b\, t^2} = \frac{24.60 * 10^6}{25 * 500 * 300^2} = 0.021 \end{array}\right\} \rho < 1.0 \xrightarrow{Take} \rho = 1.0$$

$$As = As' = \mu * b * t = \rho * F_{cu} * 10^{-4} * b * t$$

$$= 1.0 * 25 * 10^{-4} * 500 * 300 = 375 \ mm^2$$

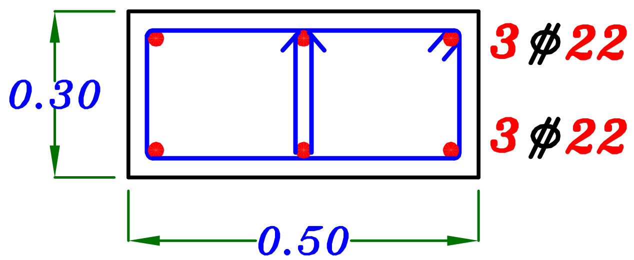
$$As_{total} = As + As' = 750 \ mm^2$$

$$As_{min} = \frac{0.25 + 0.052\, \lambda_{max}}{100} * b * t$$

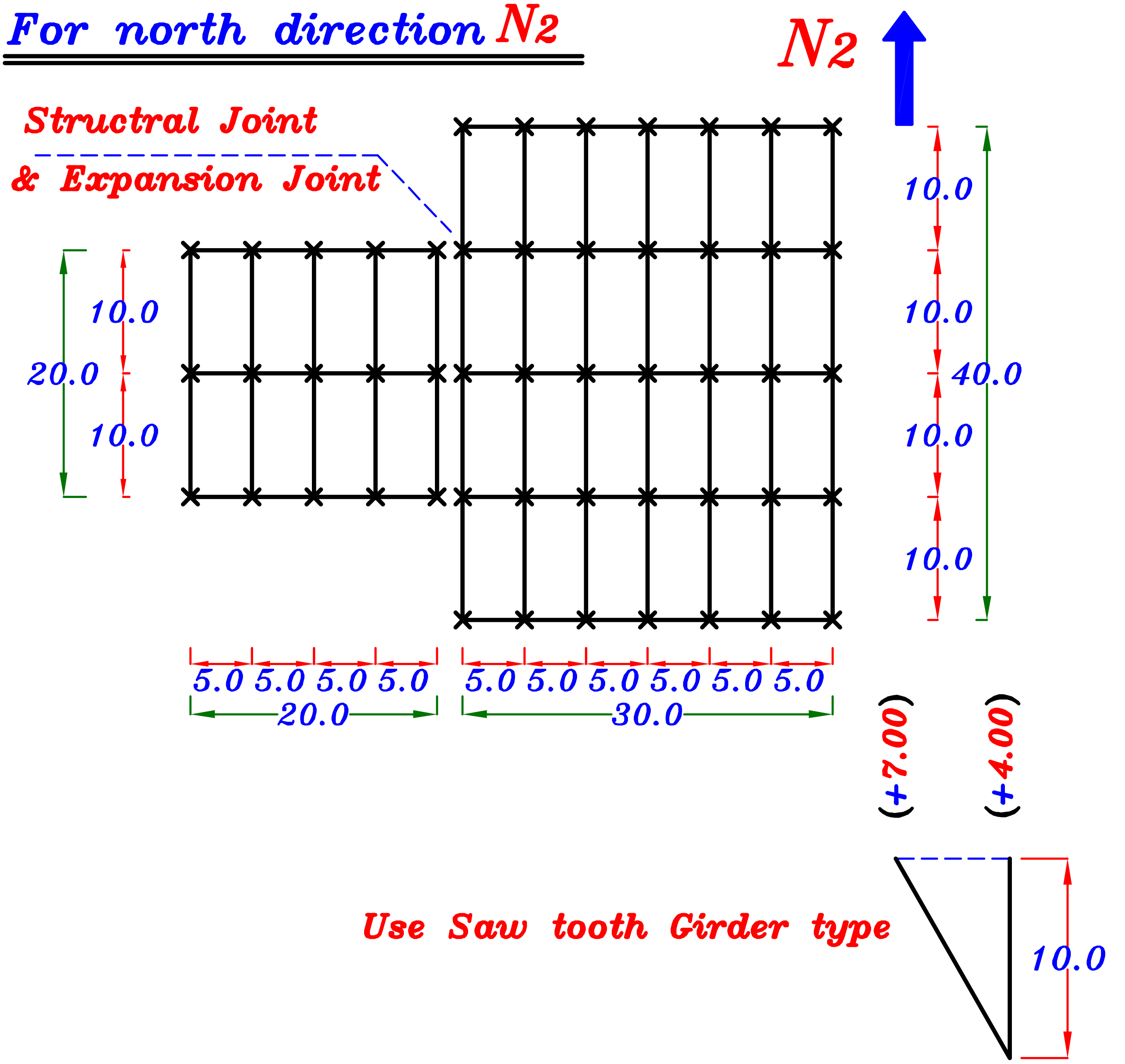
$$= \frac{0.25 + 0.052\,(16.60)}{100} * 500 * 300 = 1669.9 \ mm^2 > As_{total}$$

$$As' = As = \frac{As_{min}}{2} = \frac{1669.9}{2} = 834.9 \ mm^2$$

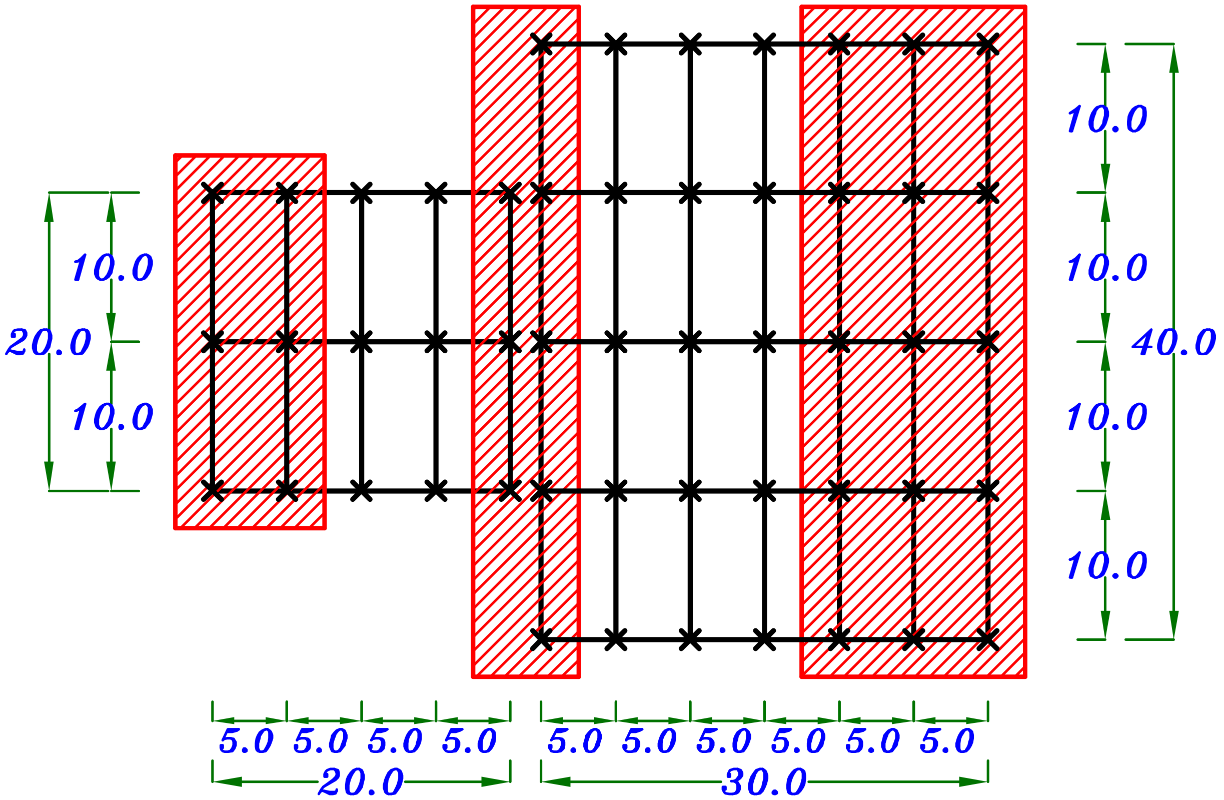
3 ϕ22

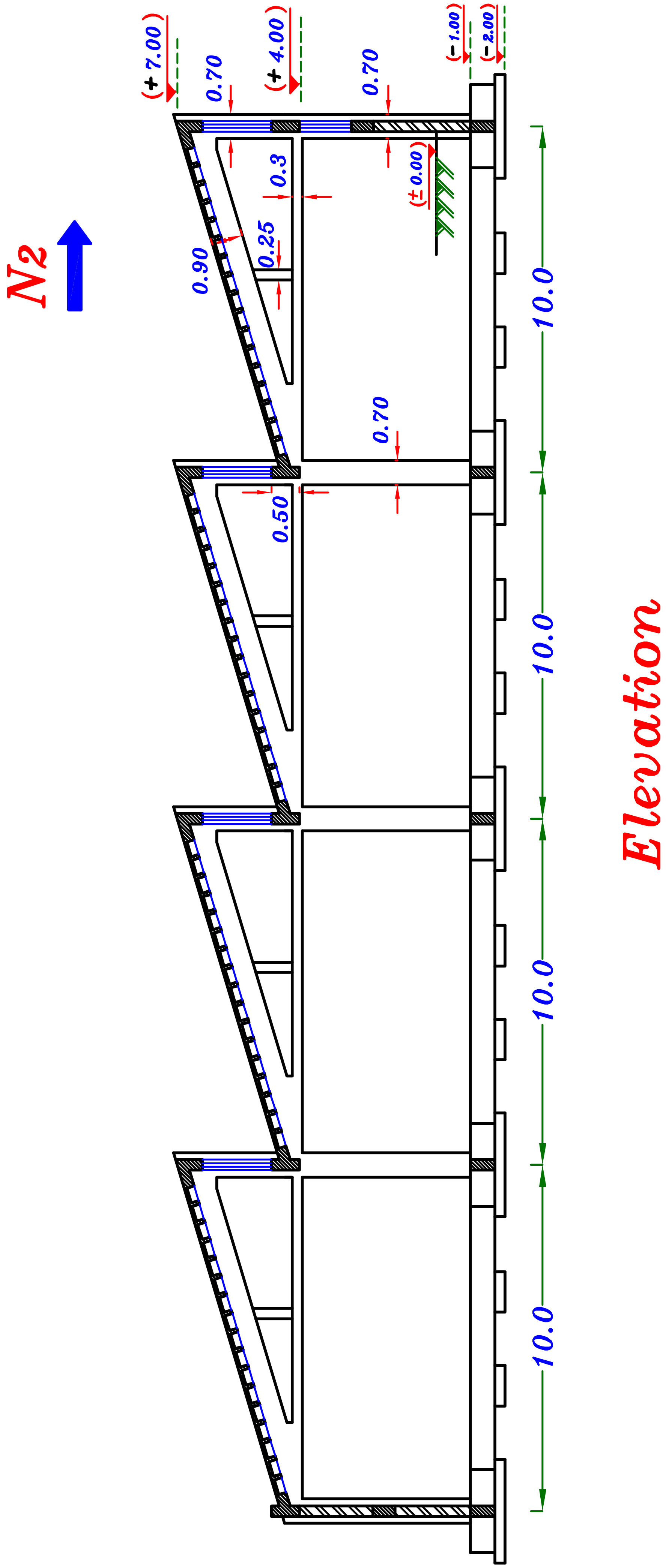


For north direction N_2

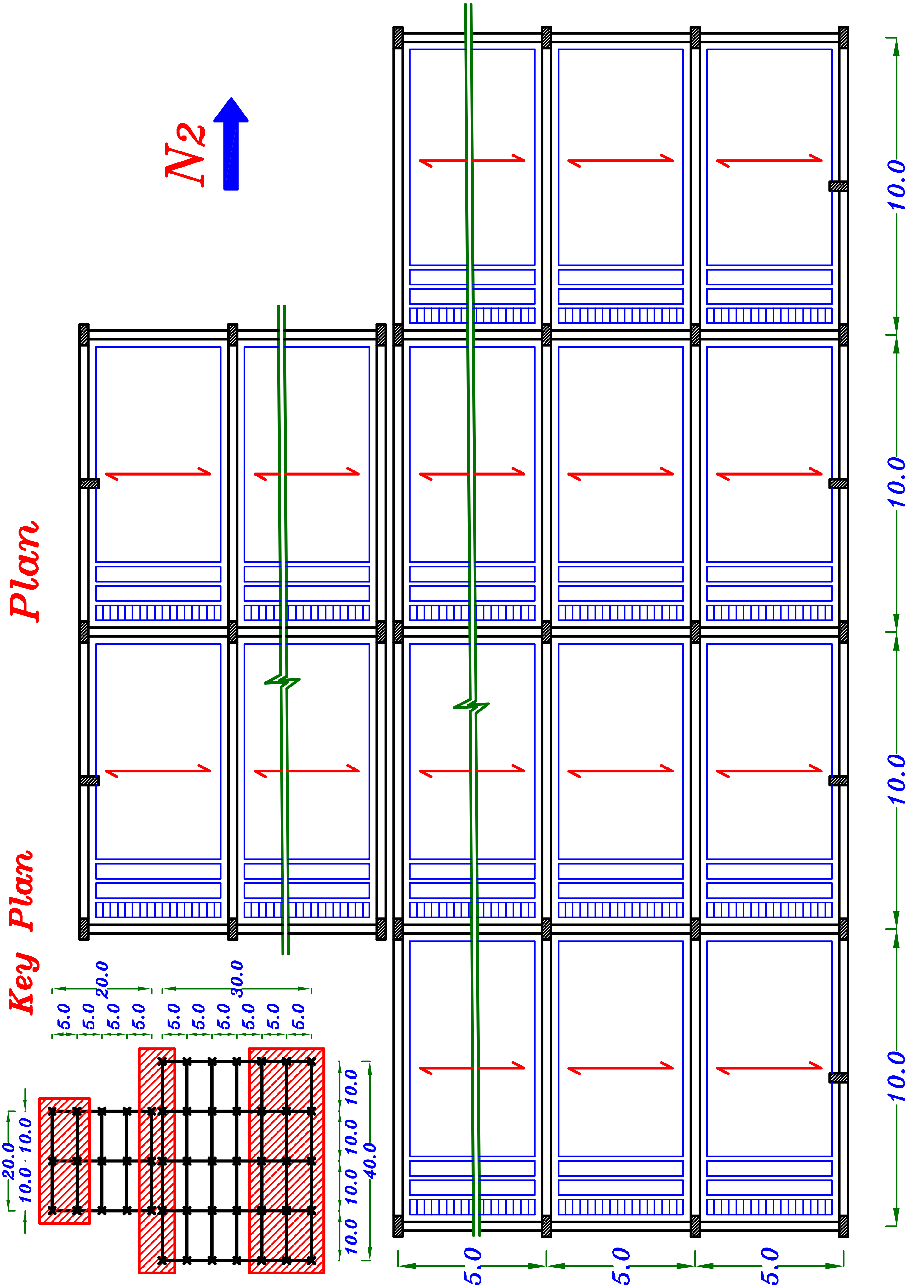


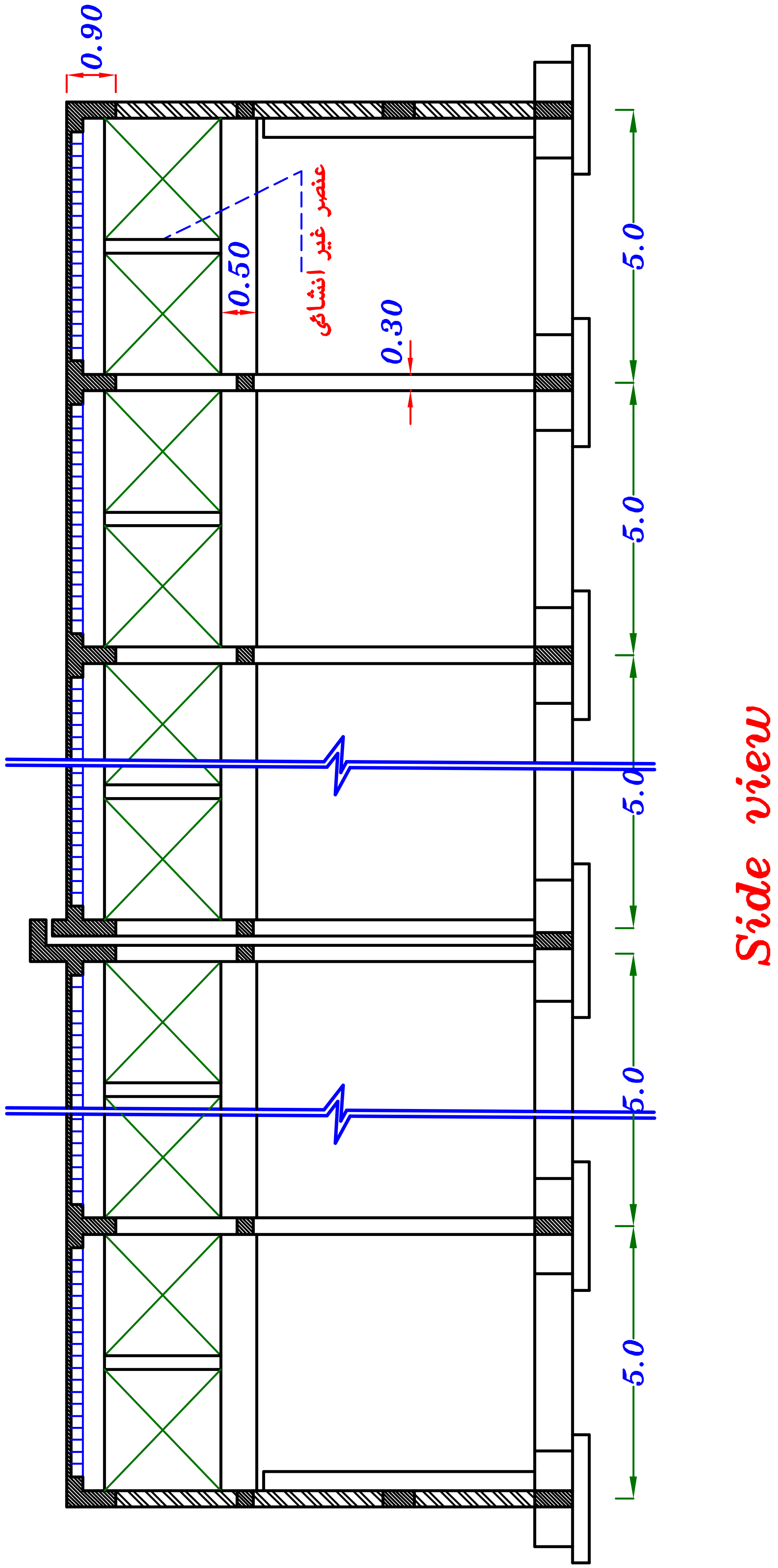
Use Saw tooth Girder type

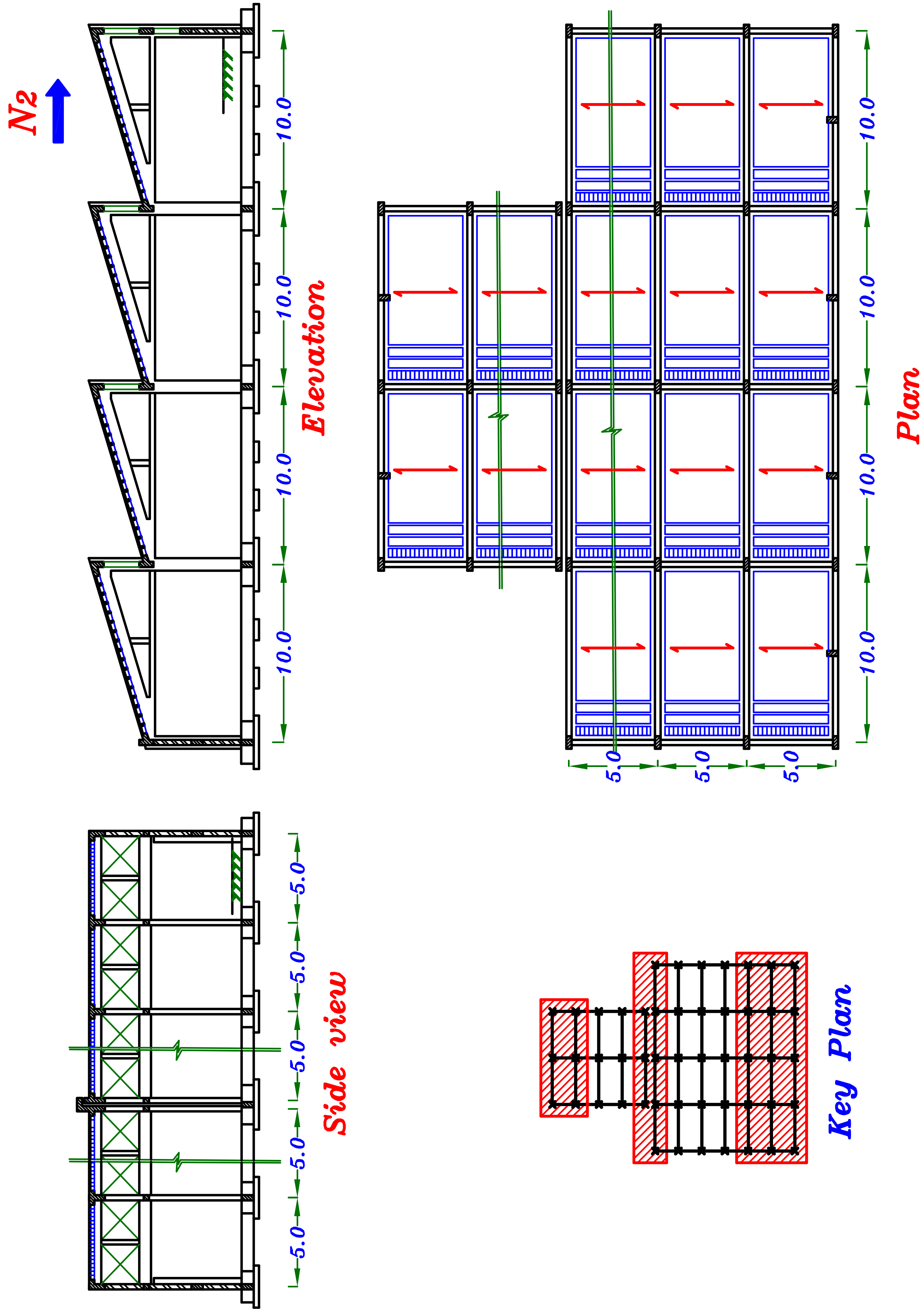



(+7.00)
(+4.00)
(−1.00)
(−2.00)
(±0.00)
0.70
0.70
0.70
0.3
0.25
0.90
0.50
10.0
10.0
10.0
10.0
N2
Elevation

Plan

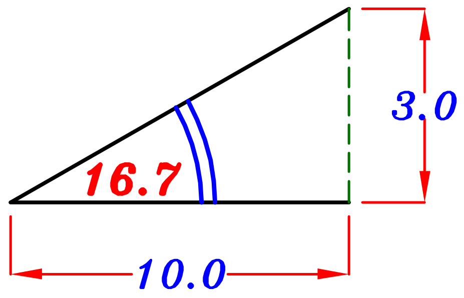

N2
10.0
10.0
10.0
10.0
5.0
5.0
5.0
Key Plan
20.0
30.0
5.0
5.0
5.0
5.0
5.0
5.0
5.0
5.0
5.0
5.0
20.0
10.0
10.0
40.0
10.0
10.0
10.0
10.0


0.90
0.50
0.30
عنصر غير انشائى
5.0
5.0
5.0
5.0
5.0
Side view


N2
Elevation
10.0
10.0
10.0
10.0
Plan
10.0
10.0
10.0
10.0
5.0
5.0
5.0
Side view
5.0
5.0
5.0
5.0
5.0
Key Plan

Design the Slab S_1

Use One Way H.B. Slab. $\alpha = 16.7^\circ$



H.B. Slab.

$$t = \frac{5000}{25} = 200\ mm$$

$\boxed{t = 200\ mm}$ $\boxed{t_s = 50\ mm}$ $\boxed{h = 150\ mm}$

$b = 0.1\ m$ $e = 0.4\ m$

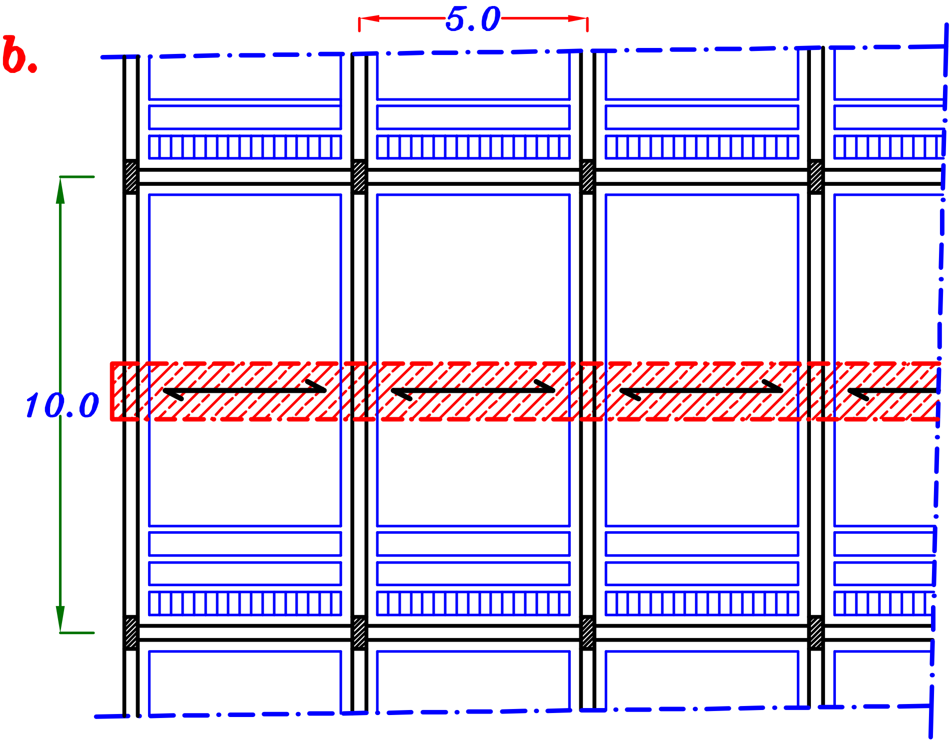
$S = e + b = 0.4 + 0.1 = 0.5\ m$

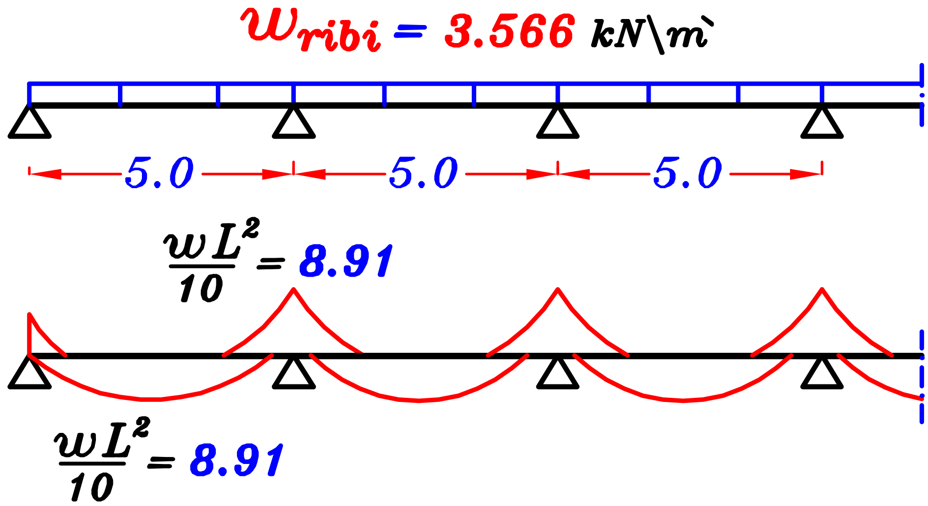
$$\boxed{w_{ribi} = \left[1.4\,(t_s \gamma_c + F.C.) + 1.6\,(L.L.)\ Cos\,\theta\right](S * 1.0) + 1.4\,(b\,h * 1.0\,m * \gamma_c) + 1.4 * (\text{Block وزن ال})\left(\frac{1.0}{\alpha}\right)}$$

$$\therefore w_{ribi} = \left[1.4\,(0.05 * 25 + 1.0) + 1.6\,(1.0)\ Cos\ 16.7^\circ\right](0.50 * 1.0) + 1.4\,(0.10 * 0.15 * 1.0 * 25) + 1.4\left(\frac{100}{1000}\right)\left(\frac{1.0}{0.2}\right) = 3.566$$

$(kN \backslash (1.0 * 0.5\ m^2))$

Strip in the Slab.





Sec. 1

∵ شريحه أفقيه فى بلاطه مائله

$M = 8.91$ kN.m\rib ∴ Designed on $M \cos \alpha$

$M_{des.} = 8.91 * \cos 16.7^\circ = 8.53$

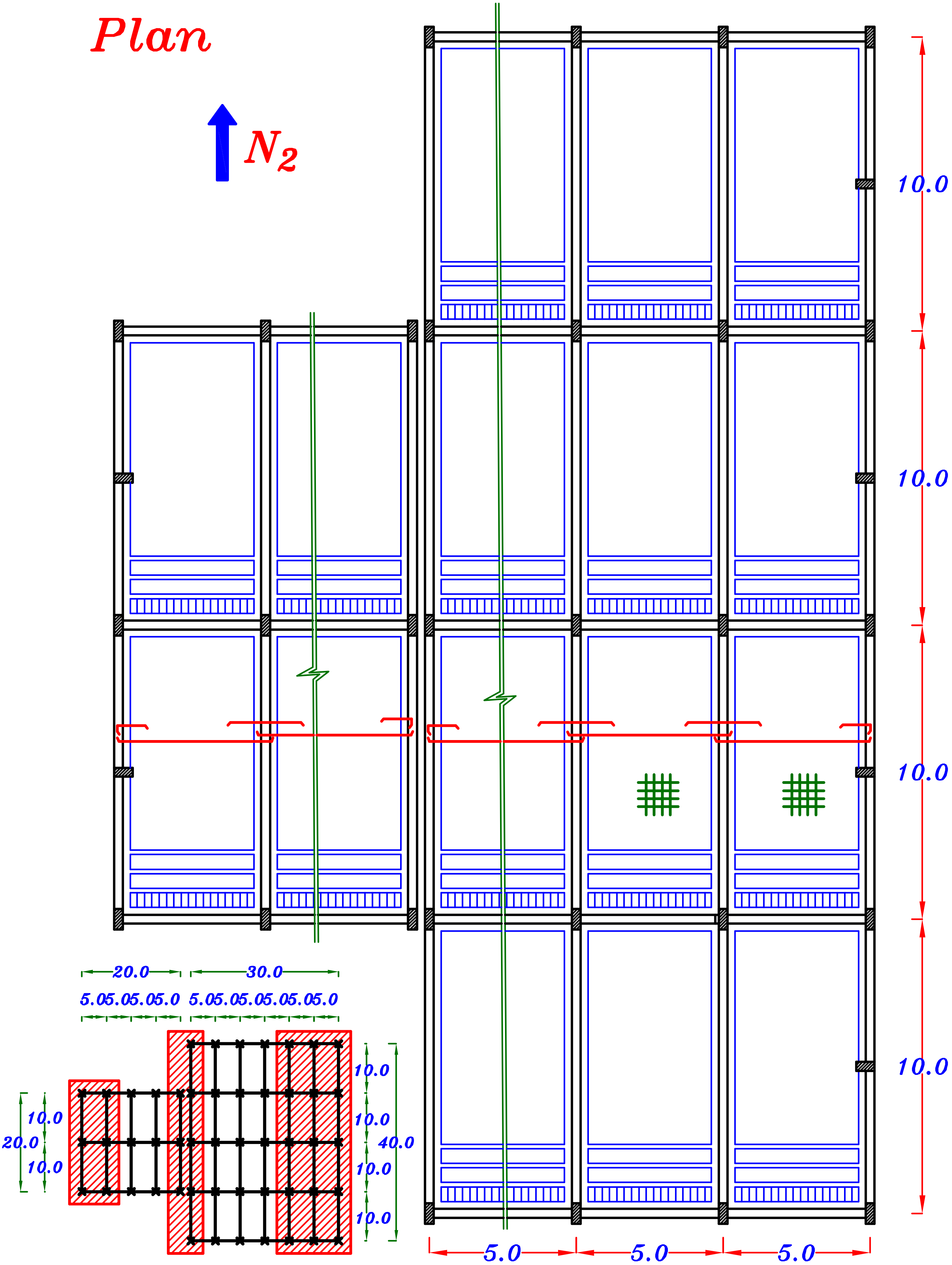
$d = t - 30 \text{ mm} = 200 - 30 = 170$

$$\therefore\ 170 = C_1 \sqrt{\frac{8.53 * 10^6}{25 * 500}} \longrightarrow C_1 = 6.50 \longrightarrow J = 0.826$$

$$A_s = \frac{M}{J\ F_y d} = \frac{8.53 * 10^6}{0.826 * 360 * 170} = 168.7\ mm^2\backslash rib$$

$\boxed{2\phi 12\backslash rib}$

Plan

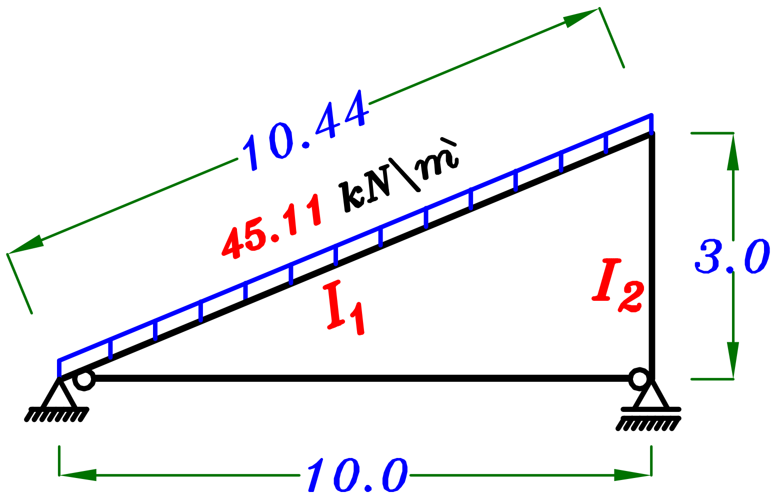


N2
10.0
10.0
10.0
10.0
5.0
5.0
5.0
20.0
30.0
5.05.05.05.0
5.05.05.05.05.05.0
10.0
10.0
20.0
10.0
10.0
10.0
40.0
10.0

Loads on Girder.

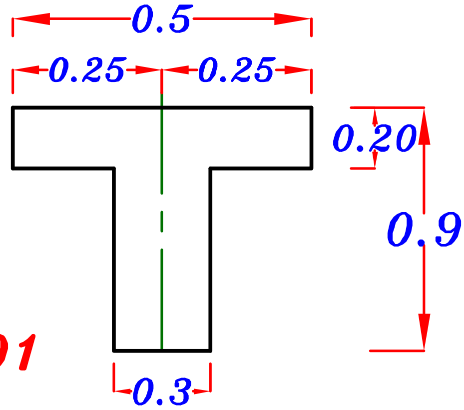
Take o.w. (Girder) $= 1.4 * 0.3 * 0.9 * 25 = 9.45$ kN\m`

$$w = o.w. + 2\left(\frac{w_{rib}}{S}\right)\frac{L_s}{2} = 9.45 + 2\left(\frac{3.566}{0.5}\right)\left(\frac{5.0}{2}\right) = 45.11 \text{ kN\m`}$$



I_1

$$I_1 = (\mu * 10^{-4})\, B\, t^3$$



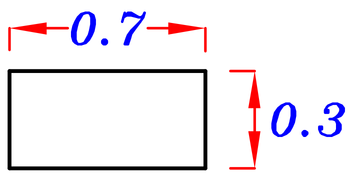
$b = 0.30$ m , $t_s = 0.20$ m

$B = 0.50$ m , $t = 0.9$ m

$$\left.\begin{aligned} \frac{t_s}{t} &= \frac{0.20}{0.9} = 0.22 \\ \frac{b}{B} &= \frac{0.30}{0.50} = 0.60 \end{aligned}\right\} \text{From Tables page 91} \quad \mu = 620$$

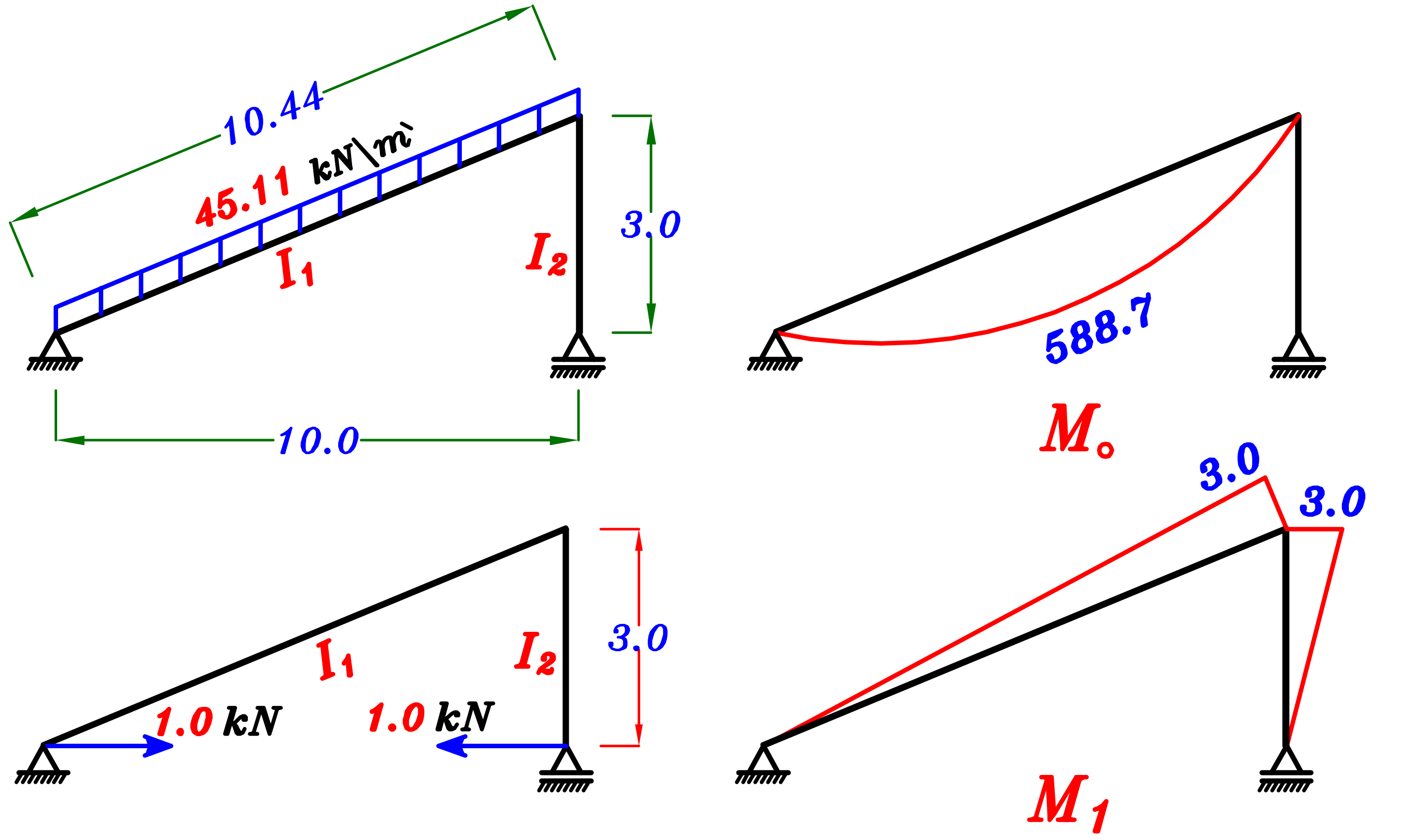
$$I_1 = (\mu * 10^{-4})\, B\, t^3 = (620 * 10^{-4} * 0.5 * 0.9^3) = 0.0226 \text{ m}^4$$

I_2



$$I_2 = \frac{b\,(0.8\,t)}{12} = \frac{0.30\,(0.7)^3}{12} = 0.0085 \text{ m}^4$$

$$\therefore \boxed{I_1 = 2.66\, I_2}$$



$$\delta_{1\circ} = \frac{1}{E_c I_1} * (M_\circ * M_1) + \frac{1}{E_c I_2} * (M_\circ * M_1)$$

$$\delta_{1\circ} = \frac{-1}{E_c\,(2.66\,)\,I_2}\left(\frac{2}{3}(\,588.7\,)(\,10.44\,)\,(\frac{1}{2} * 3.0)\right) + zero = \frac{-2310.53}{E_c\; I_2}$$

$$\delta_{11} = \frac{1}{E_c I_1} * (M_1 * M_1) + \frac{1}{E_c I_2} * (M_1 * M_1)$$

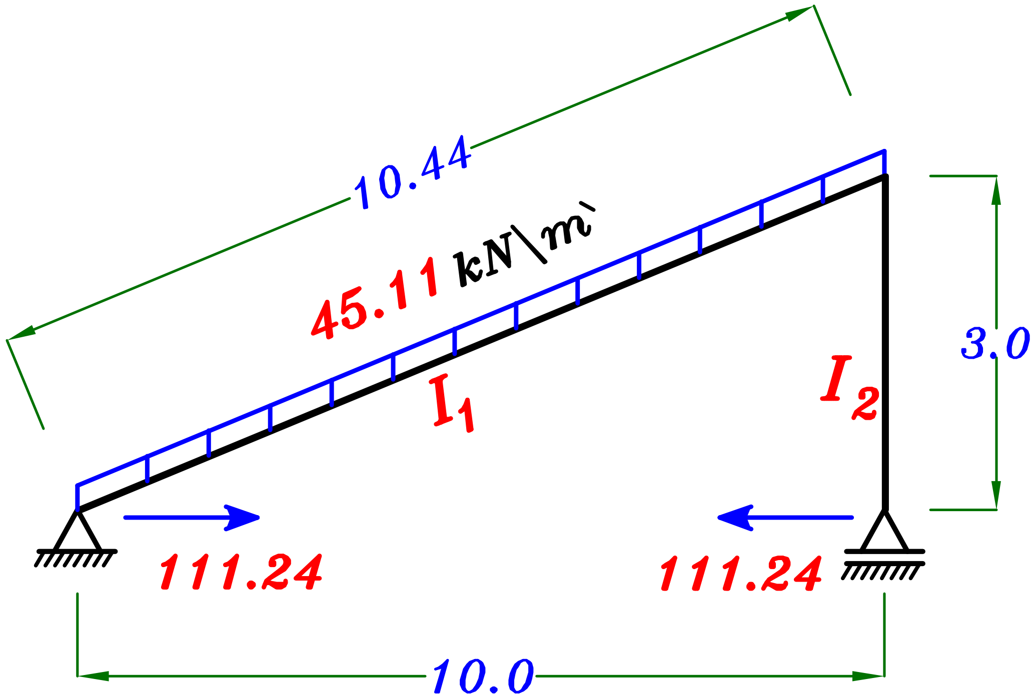
$$\delta_{11} = \frac{1}{E_c\,(2.66\,)\,I_2}\left(\frac{1}{2}(3.0)(\,10.44\,)\,(\frac{2}{3} * 3.0)\right)$$

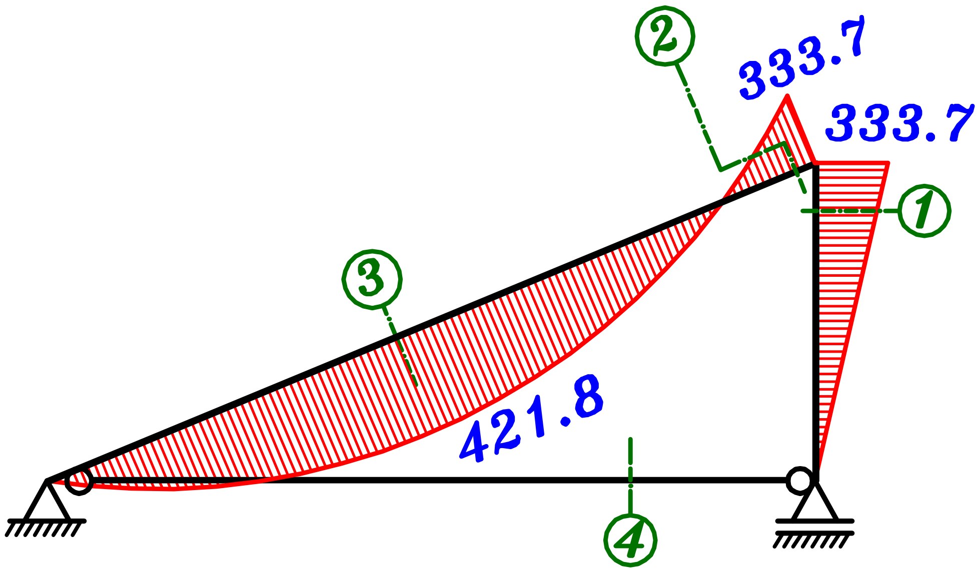
$$+ \frac{1}{E_c\; I_2}\left(\frac{1}{2}(3.0)(\,3.0\,)(\frac{2}{3} * 3.0)\right) = \frac{20.77}{E_c\; I_2}$$

Neglect the extension of Tie. $\therefore\ \Delta_{Tie} = Zero$

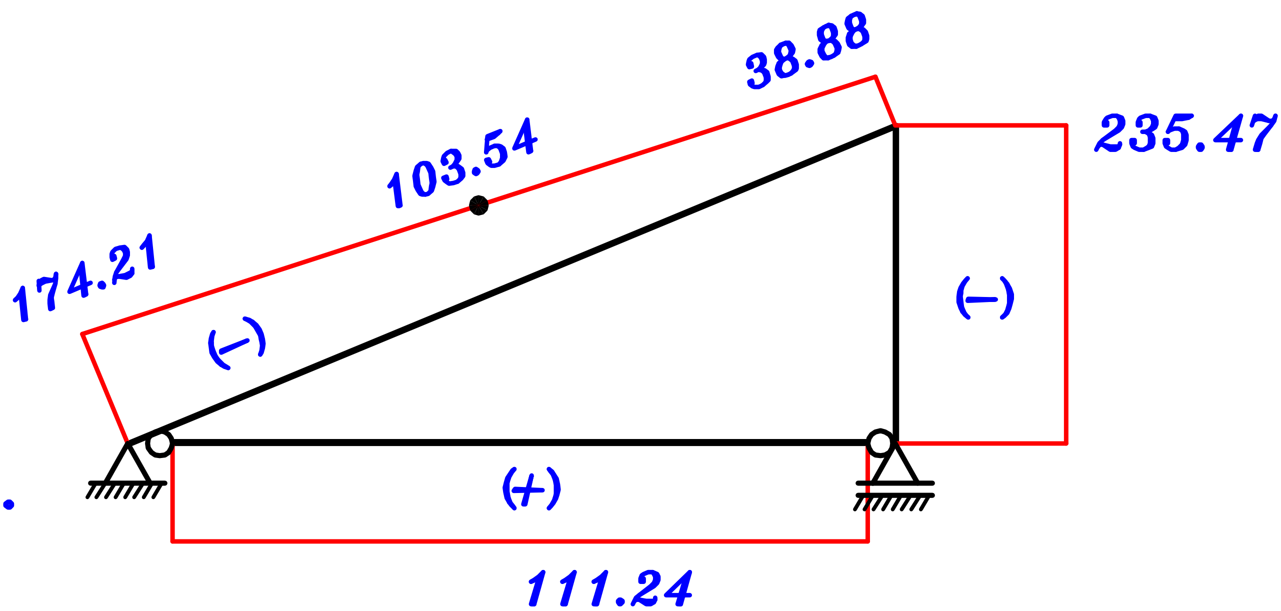
$$\because\quad \delta_{1\circ} + X\,\delta_{11} = Zero$$

$$\frac{-2310.53}{E_c\; I_2} + X * \frac{20.77}{E_c\; I_2} = Zero \longrightarrow X = 111.24\ kN$$


10.44
45.11 kN\m`
I_1
I_2
3.0
111.24
111.24
10.0


333.7
333.7
2
1
3
421.8
4

B.M.D.


38.88
235.47
103.54
174.21
(-)
(-)
(+)
111.24

N.F.D.

Design of Sections.

Sec. ① R-Sec. (300*700)

$M = 333.7$ kN.m , $P = 235.47$ kN

Check $\frac{P}{F_{cu}\, b\, t} = \frac{235.47 * 10^3}{25 * 300 * 700} = 0.044 > 0.04$ (Don't neglect P)

$e = \frac{M}{P} = \frac{333.7}{235.47} = 1.417$ m $\therefore \frac{e}{t} = \frac{1.417}{0.7} = 2.02 > 0.5 \xrightarrow{use} e_s$

$e_s = e + \frac{t}{2} - c = 1.417 + \frac{0.7}{2} - 0.05 = 1.717$ m

$M_s = P * e_s = 235.47 * 1.717 = 404.30$ kN.m

$\therefore 650 = C_1 \sqrt{\frac{404.30 * 10^6}{25 * 300}} \longrightarrow C_1 = 2.80 \longrightarrow J = 0.720$

$\therefore A_s = \frac{M_s}{J\, F_y\, d} - \frac{P_{U.L.}}{(F_y \backslash \delta_s)} = \frac{404.30 * 10^6}{0.720 * 360 * 650} - \frac{235.47 * 10^3}{(360 \backslash 1.15)}$

$= 1647.5\ mm^2$

Check $A_{s\,min.}$ $\quad A_{s_{req.}} = 1647.5\ mm^2$

$\mu_{min.}\, b\, d = \left(0.225 * \frac{\sqrt{F_{cu}}}{F_y}\right) b\, d = \left(0.225 * \frac{\sqrt{25}}{360}\right) 300 * 700 = 656.2\ mm^2$

$\therefore A_{s_{req.}} > \mu_{min.}\, b\, d \quad \therefore$ Take $A_s = A_{s_{req.}} = 1647.5\ mm^2$ $\quad 7\phi 18$

$\therefore n = \frac{b - 25}{\phi + 25} = \frac{300 - 25}{18 + 25} = 6.39 = 6.0$ bars

---

Sec. ② R-Sec.

$M = 333.7$ kN.m , $P = 38.88$ kN , $b = 300$ mm , $t = 900$ mm

Check $\frac{P}{F_{cu}\, b\, t} = \frac{38.88 * 10^3}{250 * 300 * 900} = 0.0057 < 0.04$ (neglect P)

$$\therefore 850 = C_1 \sqrt{\frac{333.7 * 10^6}{25 * 300}} \longrightarrow C_1 = 4.03 \longrightarrow J = 0.804$$

$$\therefore A_s = \frac{M_{U.L.}}{J\, F_y\, d} = \frac{333.7 * 10^6}{0.804 * 360 * 850} = 1356.3 \; mm^2$$

Check $A_{s\,min.}$ $\qquad A_{s_{req.}} = 1356.3 \; mm^2$

$$\mu_{min.}\, b\, d = \left(0.225 * \frac{\sqrt{F_{cu}}}{F_y}\right) b\, d = \left(0.225 * \frac{\sqrt{25}}{360}\right) 300 * 850 = 796.9 \; mm^2$$

$$\therefore A_{s_{req.}} > \mu_{min.}\, b\; d \quad \therefore \text{Take } A_s = A_{s_{req.}} = 1356.3 \; mm^2 \qquad 6\phi 18$$

Sec. ③ R–Sec.

$M = 421.8$ kN.m , $P = 106.54$ kN, $b = 300$ mm , $t = 900$ mm

$$\text{Check} \quad \frac{P}{F_{cu}\, b\, t} = \frac{106.54 * 10^3}{25 * 300 * 900} = 0.0157 < 0.04 \quad (\text{neglect } P)$$

$$\therefore 850 = C_1 \sqrt{\frac{421.8 * 10^6}{25 * 300}} \longrightarrow C_1 = 3.58 \longrightarrow J = 0.783$$

$$\therefore A_s = \frac{M_{U.L.}}{J\, F_y\, d} = \frac{421.8 * 10^6}{0.783 * 360 * 850} = 1760.4 \; mm^2$$

Check $A_{s\,min.}$ $\qquad A_{s_{req.}} = 1760.4 \; mm^2$

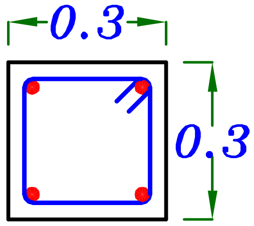
$$\mu_{min.}\, b\, d = \left(0.225 * \frac{\sqrt{F_{cu}}}{F_y}\right) b\, d = \left(0.225 * \frac{\sqrt{25}}{360}\right) 300 * 850 = 796.9 \; mm^2$$

$$\therefore A_{s_{req.}} > \mu_{min.}\, b\; d \quad \therefore \text{Take } A_s = A_{s_{req.}} = 1760.4 \; mm^2 \qquad 7\phi 18$$

Sec. ④ Tie. (300 * 300)

$$T_{(Tie)} = 111.24 \; kN$$

$$A_s = \frac{T_{(Tie)}}{F_y \backslash \gamma_s} = \frac{111.24 * 10^3}{360 \backslash 1.15} = 355.3 \; mm^2 \qquad 4\phi 12$$



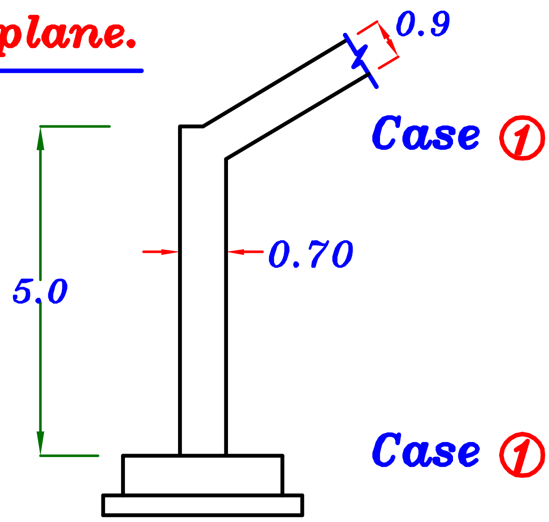
4 ϕ 12

Loads on Column (400*800)

$P = 235.47$ kN

Check Buckling of the Column.

In plane.

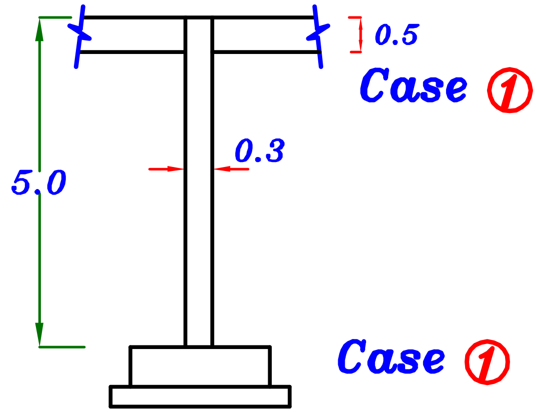


Upper Condition Case 1
Lower Condition Case 1 } $k = 1.2$

$H_o = 4.10$ m

$$\lambda_b = \frac{1.2 * 4.1}{0.7} = 7.02 < 10$$

Out of plane.



Upper Condition Case 1
Lower Condition Case 1 } $k = 1.2$

$H_o = 4.50$ m

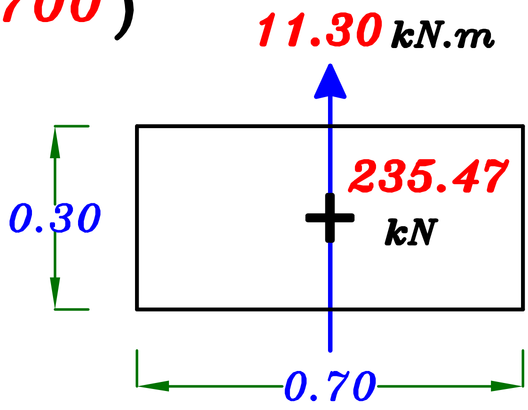
$$\lambda_b = \frac{1.2 * 4.5}{0.3} = 18.0 > 10$$

Take the bigger value of $\lambda_b = 18.0$ (Out of plane.)

$$\delta = \frac{(\lambda_b)^2 * b}{2000} = \frac{18.0^2 * 0.30}{2000} = 0.048 \text{ m}$$

$$M_{add.} = P * \delta = 235.47 * 0.048 = 11.30 \text{ kN.m}$$

Design of Column. $(300 * 700)$



$M = 11.30$ kN.m , $P = 235.47$ kN

Check $\dfrac{P}{F_{cu}\, b\, t} = \dfrac{235.47 * 10^3}{25 * 700 * 300} = 0.044 > 0.04$ (Don't neglect P)

$e = \dfrac{M}{P} = \dfrac{11.30}{235.47} = 0.048$ m $\quad \therefore \dfrac{e}{t} = \dfrac{0.048}{0.30} = 0.16 < 0.5 \xrightarrow{use}$ I.D.

$\zeta = \dfrac{0.3 - 0.1}{0.3} = 0.67 \xrightarrow{use}$ Design aids Page (4–25)

$$\left.\begin{aligned} \frac{P_U}{F_{cu}\, b\, t} &= \frac{235.47 * 10^3}{25 * 700 * 300} = 0.044 \\ \frac{M_U}{F_{cu}\, b\, t^2} &= \frac{11.30 * 10^6}{25 * 700 * 300^2} = 0.00717 \end{aligned}\right\} \rho < 1.0 \xrightarrow{Take} \rho = 1.0$$

$$As = As` = \mu * b * t = \rho * F_{cu} * 10^{-4} * b * t$$

$$= 1.0 * 25 * 10^{-4} * 700 * 300 = 525 \ mm^2$$

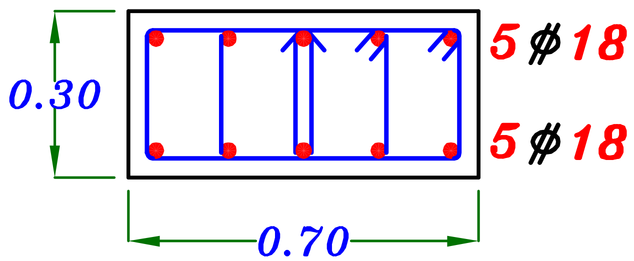
$$As_{total} = As + As` = 1050 \ mm^2$$

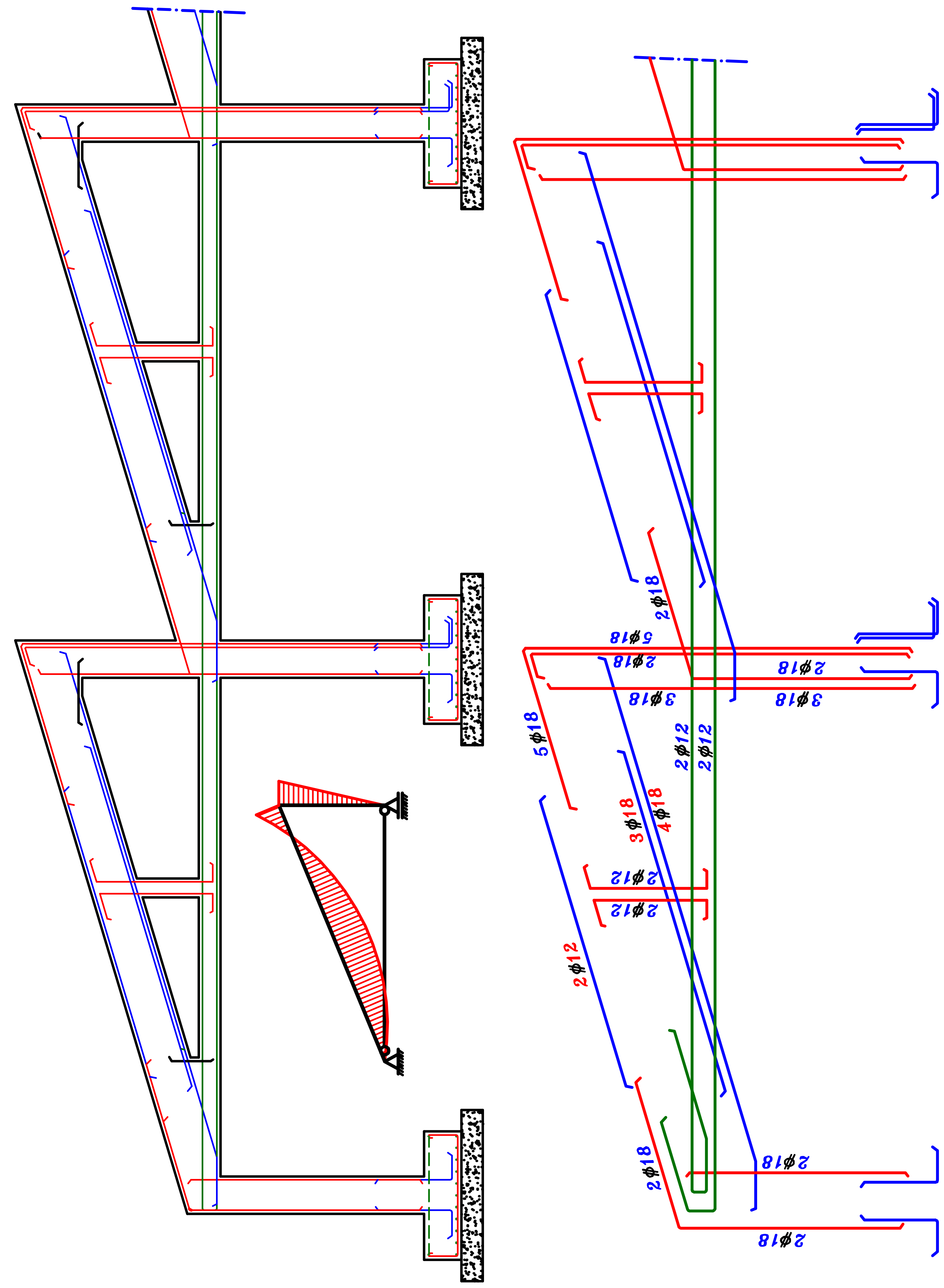
$$As_{min} = \frac{0.25 + 0.052\, \lambda_{max}}{100} * b * t$$

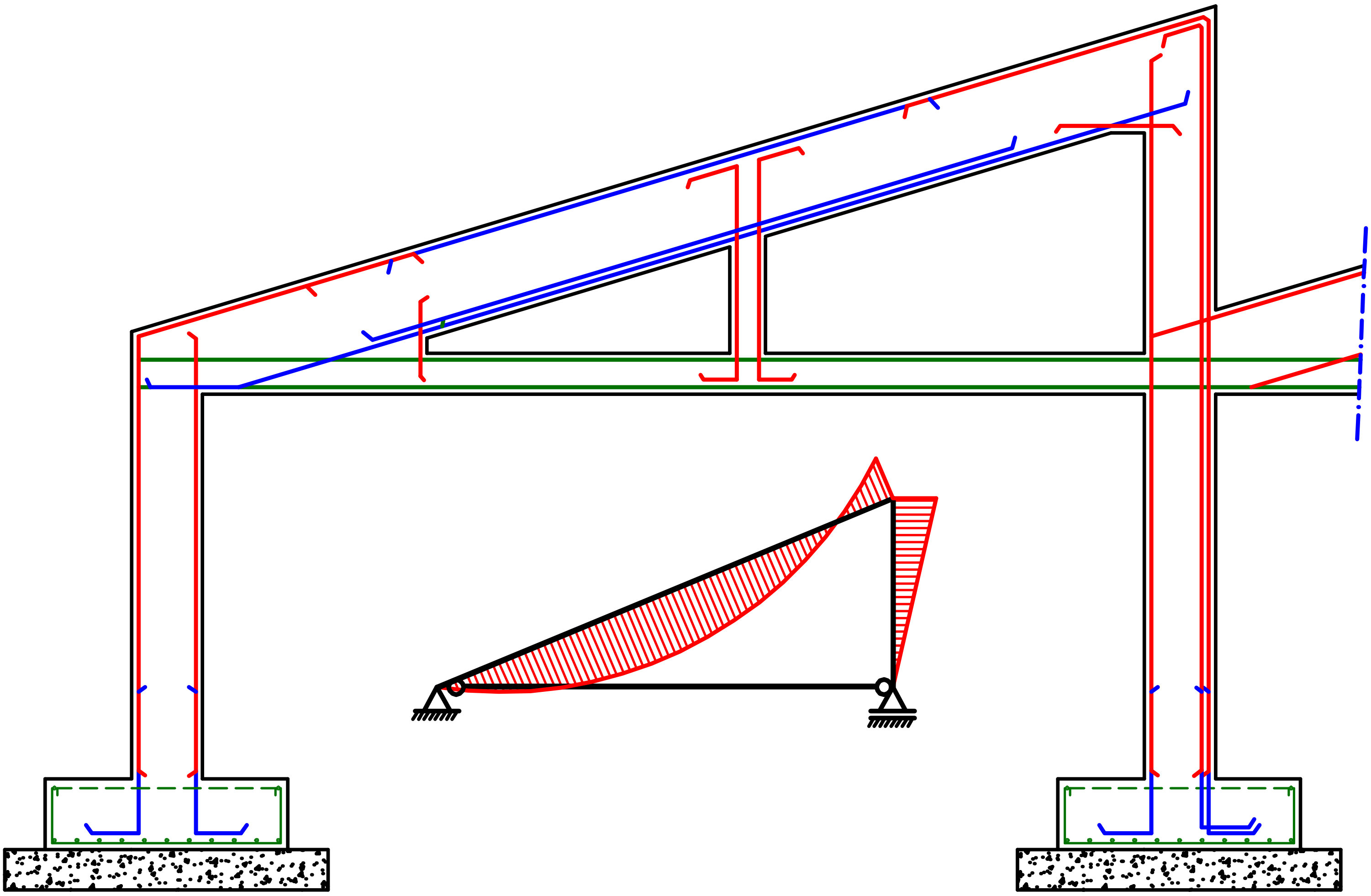
$$= \frac{0.25 + 0.052\,(18.0)}{100} * 700 * 300 = 2490 \ mm^2 > As_{total}$$

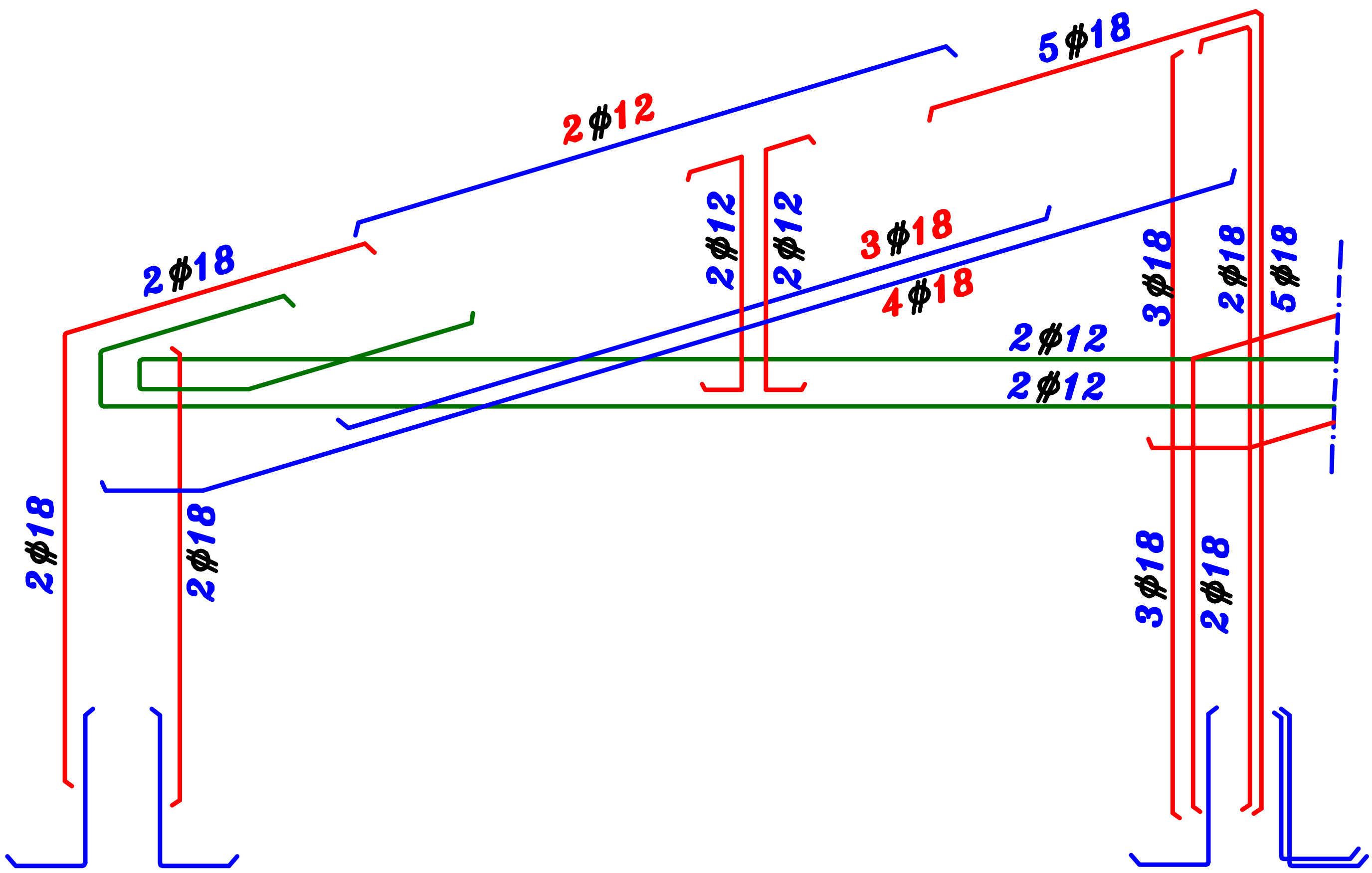
$$As` = As = \frac{As_{min}}{2} = \frac{2490}{2} = 1245 \ mm^2$$

5 ϕ 18




2Φ18
5Φ18
2Φ18
2Φ18
3Φ18
3Φ18
5Φ18
2Φ12
2Φ12
3Φ18
4Φ18
2Φ12
2Φ12
2Φ12
2Φ18
2Φ18
2Φ18




2 ϕ12
5 ϕ18
2 ϕ18
2 ϕ12
2 ϕ12
3 ϕ18
4 ϕ18
3 ϕ18
2 ϕ18
5 ϕ18
2 ϕ12
2 ϕ12
2 ϕ18
2 ϕ18
3 ϕ18
2 ϕ18